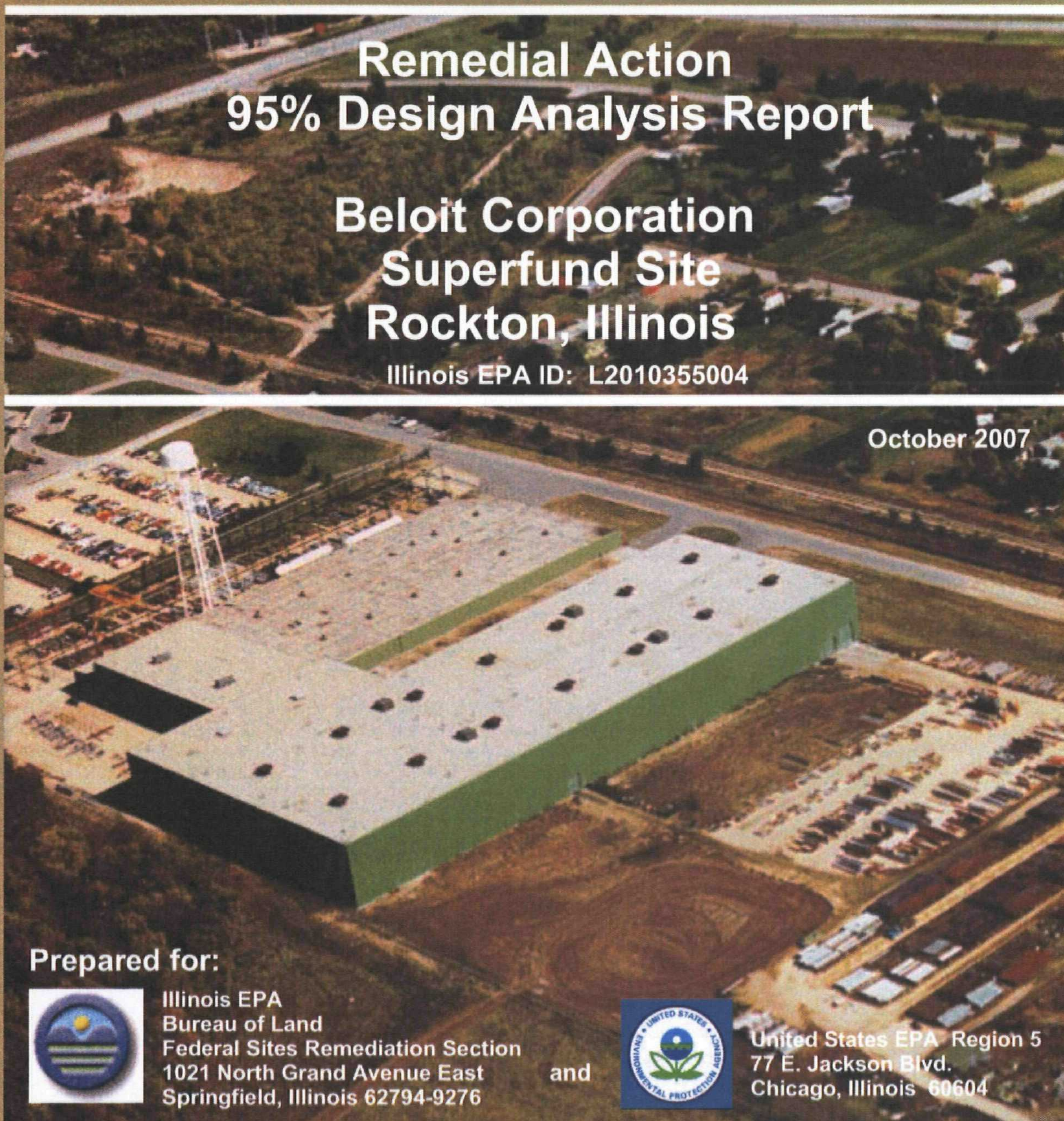

Remedial Action
95% Design Analysis Report

Beloit Corporation Superfund Site
Rockton, Illinois

Illinois EPA ID: L2010355004

October 2007

Prepared for:

Illinois EPA
Bureau of Land
Federal Sites Remediation Section
1021 North Grand Avenue East
Springfield, Illinois 62794-9276

and

United States EPA Region 5
77 E. Jackson Blvd.
Chicago, Illinois 60604

Prepared by:

ecology and environment engineering, inc.
International Specialists in the Environment

Table 3 Total Present Worth
100% Draft Final Remedial Design
Beloit Corporation Superfund Site
Rockton, Illinois

Item	Cost[1]	Years of Operation and Maintenance	Present Worth[2]
Construction	$551,000	0	$551,000
Operations and Maintenance	$250,000	20	$3,398,000
		Total Presnet Worth	**$3,949,000**

Note: [1] All costs rounded to nearest $1,000.

[2] Assumes an interest rate of 4%.

100% Draft Final Remedial Design
Construction Task Schedule

Beloit Corporation – Blackhawk Facility

Task Description	Resp. Party	Duration	Calendar Date Start	Calendar Date Finish
Finalize Design Document		**42 days**	**December 3, 2007**	**February 1, 2008**
Electrical Specs	E & E	42 days	December 3, 2007	February 1, 2008
Construction Activities		**143 days**	**January 2, 2008**	**July 18, 2008**
Construction Submittals		**25 days**	**February 4, 2008**	**March 7, 2008**
Ops Plan, HASP	BES	10 days	February 4, 2008	February 15, 2008
Review (1)	E & E	5 days	February 18, 2008	February 22, 2008
Resubmittal	BES	5 days	February 25, 2008	February 29, 2008
Review (2)	E & E	5 days	March 3, 2008	March 7, 2008
Equipment Procurement		**100 days**	January 29, 2008	June 17, 2008
Long Lead Items	BES	100 days	January 29, 2008	June 17, 2008
Shop Drawing Preparation	BES	30 days	January 29, 2008	March 11, 2008
Influent Tank Order/Delivery	BES	60 days	March 24, 2008	June 16, 2008
P&T Building Order/Delivery	BES	70 days	March 11, 2008	June 17, 2008
Fieldwork		**65 days**	**April 21, 2008**	**July 18, 2008**
Foundation Excavation	BES	5 days	April 21, 2008	April 25, 2008
Concrete Forming/Pour	BES	10 days	April 28, 2008	May 9, 2008
Concrete Curing	BES	20 days	May 12, 2008	June 6, 2008
Extraction Well Pre-Drill	BES	4 days	May 12, 2008	May 15, 2008
Pneumatic Fracturing	BES	5 days	May 13, 2008	May 19, 2008
Extraction Well Final Drill	BES	5 days	May 16, 2008	May 22, 2008
EW Development	BES	3 days	May 23, 2008	May 27, 2008
Monitoring Well Installation	BES	5 days	May 23, 2008	May 27, 2008
Force Main Trenching/Install	BES	15 days	May 26, 2008	June 13, 2008
Tank Placement	BES	1 day	June 16, 2008	June 16, 2008
Building Installation	BES	10 days	June 17, 2008	June 30, 2008
Tank Final Set	BES	1 day	June 24, 2008	June 24, 2008
Plumbing, Mechanical	BES	15 days	June 24, 2008	July 15, 2008
Electrical	BES	10 days	July 1, 2008	July 15, 2008
Programming	BES	3 days	July 16, 2008	July 18, 2008
Startup/Shakedown	**BES**	**10 days**	**July 21, 2008**	**August 1, 2008**
Construction Oversight	**E & E**	**75 days**	**April 21, 2008**	**August 1, 2008**

Procurement and Fieldwork calendar dates do not account for holidays and weekends. Weekend work will be required on certain tasks (e.g., trenching across roadways) to avoid interrupting Reload operations. Extraction well installation will require coordination with ARS Technologies.

Table 2 Yearly Operations and Maintenance Cost Estimate
100% Draft Final Remedial Design
Beloit Corporation Superfund Site
Rockton, Illinois

Item Description	Reference[1]	Amount	Unit	Labor	Equipment	Material	Unit Cost	Totals
Pump and Treat System								
Labor (1 person, 24 hours per week)	Vendor Quote	1248	HR	$40.19	$0.00	$0.00	$40.19	$50,157
Equipment Repair/Replacement	Estimate	1	LS	$0.00	$2,500.00	$5,000.00	$7,500.00	$7,500
Utilities	Bodine	12	MO	$0.00	$0.00	$3,200.00	$3,200.00	$38,400
Miscellaneous Supplies	Estimate	1	LS	$0.00	$500.00	$1,000.00	$1,500.00	$1,500
Pump and Treat System Total:								**$98,000**
Pump and Treat System Compliance Sampling								
Influent VOC Analysis (3-day turnaround)	33-02-1618	40	EA	$0.00	$0.00	$0.00	$235.55	$9,422
Influent pH Analysis	33-02-1602	40	EA	$0.00	$0.00	$0.00	$7.15	$286
Effluent VOC Analysis (3-day turanaround)	33-02-1618	24	EA	$0.00	$0.00	$0.00	$235.55	$5,653
Effluent pH Analysis	33-02-1602	24	EA	$0.00	$0.00	$0.00	$7.15	$172
Shipping (cooler weighs 20 pounds)	33-02-2042	24	EA	$0.00	$0.00	$38.60	$38.60	$926
Miscellaneous Supplies	Estimate	1	LS	$0.00	$0.00	$250.00	$250.00	$250
Pump and Treat System Compliance Sampling Total:								**$17,000**
Groundwater Sampling and Analysis (Four sampling events)								
Labor (2 people, 10 hours/day, 7 days for each event)	33-22-0108	560	HR	$48.58	$0.00	$0.00	$48.58	$27,205
VOC Analysis (21-day turnaround)	33-02-1618	150	EA	$0.00	$0.00	$0.00	$117.78	$17,666
pH Analysis	33-02-1602	122	EA	$0.00	$0.00	$0.00	$7.15	$872
Shipping (7 coolers per event weighing 20 pounds each)	33-02-2042	28	EA	$0.00	$0.00	$38.60	$38.60	$1,081
Equipment Shipping (assume each piece weights 25 pounds)	33-02-2042	12	EA	$0.00	$0.00	$48.25	$48.25	$579
2" Submersible Pump (Rental)	33-23-0517	8	WK	$0.00	$0.00	$247.78	$247.78	$1,982
Portable Generator (Rental)	33-01-0503	28	DY	$0.00	$0.00	$0.00	$67.06	$1,878
pH/DO/Conductivity/Temperature Meter (Rental)	33-02-0571	8	WK	$0.00	$0.00	$80.22	$80.22	$642
Water Level Indicator (Rental)	33-02-0572	8	WK	$0.00	$0.00	$0.00	$68.33	$547
Truck Rental	33-01-0102	28	DY	$0.00	$0.00	$39.19	$39.19	$1,097
Per Diem	Illinois State Rate	56	DY	$0.00	$0.00	$28.00	$28.00	$1,568
Lodging	Illinois State Rate	40	DY	$0.00	$0.00	$60.00	$60.00	$2,400
Miscellaneous Field Supplies	Estimate	4	EA	$0.00	$200.00	$200.00	$400.00	$1,600
Groundwater Sampling and Analysis Total:								**$59,000**
Reporting								
NPDES Permit and DMRs	Bodine	1	LS	$9,856.00	$0.00	$957.44	$10,813.44	$10,813
						Reporting Total:		**$11,000**
Component Subtotal								$185,000
Overhead and Profit	25%							$46,250
Contingency	10%							$18,500
Grand Total Yearly Operations and Maintenance Cost (Rounded to Nearest $1,000)								**$250,000**

Note:

1 Reference Format (##-##-####) is for *Environmental Remediation cost Data - Assemblies*, by RS Means, 2006.

Key:

HR = Hour.
LS = Lump Sum.
EA = Each.
MO = Month.
WK = Week.
DY = Day.

Table 1 Construction Cost Estimate
100% Draft Final Remedial Design
Beloit Corporation Superfund Site
Rockton, Illinois

Item Description	Reference[1]	Amount	Unit	Labor	Equipment	Material	Unit Cost	Totals
Support Structure								
Planning Documents	Estimate	1	EA	$18,750.00	$0.00	$0.00	$18,750.00	$18,750
Utility Clearance	Estimate	1	EA	$1,500.00	$500.00	$0.00	$2,000.00	$2,000
Construction Trailer 32x8	01520-500-0350	4	MO	$0.00	$183.00	$0.00	$183.00	$732
Block and Tie down Trailer	Estimate	1	LS	$0.00	$0.00	$0.00	$250.00	$250
Storage Box 20x8	01520-500-1250	4	MO	$0.00	$75.00	$0.00	$75.00	$300
Storage Box delivery	Estimate	1	LS	$0.00	$0.00	$0.00	$425.00	$425
Office Equipment rental and Supplies	01520-550-0100	4	MO	$0.00	$145.00	$0.00	$145.00	$580
Office Utilities (phone, elec.)	01520-550-0140	4	MO	$0.00	$210.00	$0.00	$210.00	$840
Portable Toilet	01590-400-6410	4	MO	$0.00	$159.00	$0.00	$159.00	$636
Mob/Demob pickup w/ equipment	02305-250-1100	1	EA	$63.90	$0.00	$162.00	$225.90	$226
Mob/Demob excavator	02305-250-0020	1	EA	$672.00	$0.00	$330.00	$1,002.00	$1,002
Mob/Demob equipment and crew	33-01-0101	1	LS	$748.00	$3,379.00	$0.00	$4,127.00	$4,127
Electric Hookup	Estimate	1	LS	$0.00	$0.00	$0.00	$750.00	$750
Record Drawings	Estimate	1	LS	$700.00	$50.00	$50.00	$800.00	$800
							Support Structure Total	$31,400
Surveying								
Surveying	99-04-1201	3	DY	$692.40	$222.10	$0.00	$914.50	$2,744
Grade Stakes	Estimate	1	LS	$0.00	$0.00	$210.00	$210.00	$210
Laser Level Rental	Estimate	3	MO	$0.00	$315.00	$0.00	$315.00	$945
GPS Unit Rental	Estimate	3	MO	$0.00	$900.00	$0.00	$900.00	$2,700
							Surveying Total	$6,600
Metal Building								
Mob/Demob/Setup Crane	02305-250-0020	2	EA	$672.00	$0.00	$330.00	$1,002.00	$2,004
Excavation and gravel fill with 4' deep footings	A2010-110-2260	280	SF	$0.65	$1.20	$2.35	$4.20	$1,176
Strip Footing	A1010-110-3000	90	LF	$9.00	$4.03	$12.53	$25.56	$2,300
Slab on Grade Foundation (AST Foundation)	A1030-120-4560	117	SF	$7.10	$0.00	$4.37	$11.47	$1,342
Slab-On-Grade Foundation Reinforced	A1030-120-3440	163	SF	$6.95	$0.00	$3.78	$10.73	$1,749
Foundation Walls	A2020-110-2260	50	LF	$30.00	$16.50	$35.00	$81.50	$4,075
Foundation Dampproofing, 4' high	A1010-320-5000	50	LF	$4.00	$0.92	$2.80	$7.72	$386
Equipment Building w/ installation	Vendor Quote	1	LS	$0.00	$0.00	$45,000.00	$45,000.00	$45,000
							Metal Building Total	$58,000
Building Mechanical Systems								
Slab-on-Grade (AST Housekeeping Pad)	A1030-120-2220	120	SF	$2.25	$0.43	$2.35	$5.03	$604
Equalization Tank	Vendor Quote	1	EA	$0.00	$0.00	$19,430.25	$19,430.25	$19,430
Slab-on-Grade (Transfer Pump Pad)	A1030-120-2220	25	SF	$2.25	$0.43	$2.35	$5.03	$126
Transfer Pump	Vendor Quote	1	EA	$0.00	$0.00	$5,537.28	$4,152.96	$4,153
Sump Pump	33-29-0414	1	EA	$86.20	$0.00	$871.73	$957.93	$958
Steel Grating for Sump	19-02-0604	16	SF	$2.77	$0.12	$10.11	$13.00	$208
Slab-on-Grade (Vehicle Ramp)	A1030-120-2220	30	SF	$2.25	$0.43	$2.35	$5.03	$151
							Building Mechanical Systems Total	$25,600
Force Main								
Trenching, excavation, backfill, and compaction	G1030-805-1340	550	LF	$3.89	$1.26	$0.00	$5.15	$2,833
Asphalt pavement demolition	02 41 13.17 5050	183	SY	$1.90	$1.30	$0.00	$3.20	$587
Pipe Bedding, borrow sand, spread, compact	G1030-815-1460	550	LF	$0.68	$0.50	$1.02	$2.20	$1,210
HDPE Pipe, Forcemain	33-26-0502	565	LF	$5.35	$0.00	$0.46	$5.81	$3,283
Elbows 2" Dia HDPE	33-27-0311	10	EA	$30.54	$0.00	$25.50	$56.04	$560
							Force Main Total	$8,500
Extraction Wells								
Concrete Bollard	33-23-2301	9	EA	$67.32	$0.06	$52.78	$120.16	$1,081
Air Rotary, 6" Dia Borehole Depth <= 100 feet	33-23-1126	180	LF	$10.26	$46.33	$0.00	$56.59	$10,186
Borehole Fracturing	Vendor Quote	1	LS	$15,772.50	$0.00	$0.00	$15,772.50	$15,773
Air Rotary, 16" Dia Borehole Depth <= 100 feet	33-23-1157	180	LF	$29.49	$133.20	$0.00	$162.69	$29,284
Extraction Well Screen 8" Dia Stainless Steel	33-23-0244	105	LF	$0.00	$0.00	$92.27	$92.27	$9,688
Extraction Well Casing 8" Dia Carbon Steel	33-26-0106	75	LF	$14.30	$0.82	$20.21	$35.33	$2,650
Concrete Pad 4' x 4' x 4"	33-23-1502	3	EA	$121.38	$4.12	$64.58	$190.08	$570
Annular Seal (Bentonite Grout)	33-23-1806	62	LF	$62.83	$16.00	$16.48	$95.31	$5,909
Bentonite Seal	33-23-2105	3	EA	$46.29	$209.13	$56.09	$311.51	$935
Sand Pack, 8" Screen, Filter Pack	33-23-1403.5	111	LF	$7.16	$32.39	$11.61	$51.16	$5,679
2" Dia Steel Pitless Adaptor, Tee	33-27-0203	3	EA	$718.83	$79.62	$953.41	$1,751.86	$5,256
Protective Casing	33-23-2217	3	EA	$74.80	$337.90	$174.65	$587.35	$1,762
4" Submersible Pump w/controls	33-23-0542	3	EA	$0.00	$0.00	$2,070.00	$2,070.00	$6,210
8" Well, Locking Cap	33-23-1703	3	EA	$31.17	$140.79	$28.28	$200.24	$601
Screen Cap, 8" Stainless Steel Plug	33-23-0333	3	EA	$0.00	$0.00	$295.03	$295.03	$885
							Extraction Wells Total	$96,500
Monitoring Wells								
Aboveground Completion								
Concrete Bollard	33-23-2301	12	EA	$67.32	$0.06	$52.78	$120.16	$1,442
Protective Enclosure With Cover	33-23-2252	4	EA	$46.75	$211.19	$132.08	$390.02	$1,560
Locking Cap for Riser, Watertight	33-23-1701	4	EA	23.38	105.59	13.6	$142.57	$570
Well Riser 2" Dia Stainless Steel	33-26-0213	162	LF	$9.34	$0.00	$18.17	$27.51	$4,457
Concrete Pad 4' x 4' x 4"	33-23-1502	4	EA	$121.38	$4.12	$64.58	$190.08	$760
Annular Seal (Bentonite Grout)	33-23-1804	120	LF	$41.89	$5.00	$10.99	$57.88	$6,946
Bentonite Seal	33-23-2105	4	EA	$46.29	$209.13	$56.09	$311.51	$1,246

Table 1 **Construction Cost Estimate**
100% Draft Final Remedial Design
Beloit Corporation Superfund Site
Rockton, Illinois

Item Description	Reference[1]	Amount	Unit	Labor	Equipment	Material	Unit Cost	Totals
Sand Pack, 2" Screen, Filter Pack	33-23-1401	38	LF	2.12	9.57	3.43	$15.12	$575
Well Screen, 2" Dia Stainless Steel	33-23-0221	30	LF	$2.49	$11.26	$14 49	$28.24	$847
Air Rotary, 8" Dia Borehole Depth <= 100 feet	33-23-1148	180	LF	$11.54	$52.12	$0.00	$63.66	$11,459
Well Bottom Plug, 2" Threaded Stainless Steel	33-23-0311	4	EA	$7.48	$33.79	$46.97	$88.24	$353
At-Grade Completion								
Bolted Steel Cap, 8" x 7.5"	33-23-2211	2	EA	$70.13	$316.78	$64.96	$451.87	$904
Locking Cap for Riser, Watertight	33-23-1701	2	EA	23.38	105.59	13.6	$142.57	$285
Well Riser 2" Dia Stainless Steel	33-26-0213	75	LF	$9.34	$0.00	$18.17	$27.51	$2,063
Concrete Pad 4' x 4' x 4"	33-23-1502	2	EA	$121.38	$4.12	$64.58	$190.08	$380
Annular Seal (Bentonite Grout)	33-23-1804	60	LF	$41.89	$5.00	$10.99	$57.88	$3,473
Bentonite Seal	33-23-2105	2	EA	$46.29	$209.13	$56.09	$311.51	$623
Sand Pack, 2" Screen, Filter Pack	33-23-1401	19	LF	$2 12	$9.57	$3.43	$15.12	$287
Air Rotary, 8" Dia Borehole Depth <= 100 feet	33-23-1148	90	LF	$11 54	$52.12	$0.00	$63.66	$5,729
Well Bottom Plug, 2" Threaded Stainless Steel	33-23-0311	2	EA	$7.48	$33.79	$46.97	$88.24	$176
Well Screen, 2" Dia Stainless Steel	33-23-0221	15	LF	$2.49	$11 26	$14.49	$28.24	$424
							Monitoring Well Total	**$44,600**
Well Upgrades and Abandonment								
Abandon 2" wells	33-23-1822	55	LF	$4.82	$21.76	$0.82	$27.40	$1,507
Repair 21 monitoring wells	Estimate	1	LS	$3,500.00	$0.00	$750.00	$4,250.00	$4,250
Survey repaired monitoring wells	99-04-1201	1	DY	$692.40	$222 10	$0.00	$914.50	$915
							Well Upgrades and Abandonment Total	**$5,800**
Site Restoration and Debris Diposal								
Asphalt Replacement and ramp to building	32 12 16.14 0020	1650	SF	$0.17	$0.22	$1.73	$2.12	$3,498
Haul to Landfill, asphalt and building debris	17-02-0402	41	CY	$0.00	$0.00	$23.28	$23.28	$953
Transport Excess Soil (Trenching & Drill Cuttings)	33-19-0205	660	MI	$0.00	$0.00	$1.75	$1.75	$1,155
Disposal Excess Soil (Assume Non-Haz)	33-19-7269	41	CY	$0.00	$0.00	$74.81	$74.81	$3,062
Waste Profile Analysis	Vendor Quote	1	EA	$0.00	$0.00	$0.00	$2,500.00	$2,500
							Site Restoration and Debris Disposal Total	**$11,200**
System Start-Up Sampling and Analysis								
Pump and Treat System								
Influent VOC Analysis (3-day turnaround)	33-02-1618	28	EA	$0.00	$0.00	$0.00	$235.55	$6,595
Influent pH Analysis	33-02-1602	28	EA	$0.00	$0.00	$0.00	$7.15	$200
Effluent VOC Analysis (3-day turanaround)	33-02-1618	4	EA	$0.00	$0.00	$0.00	$235.55	$942
Effluent pH Analysis	33-02-1602	4	EA	$0.00	$0.00	$0.00	$7.15	$29
Shipping (cooler weighs 20 pounds)	33-02-2042	4	EA	$0.00	$0.00	$38.60	$38.60	$154
Miscellaneous Supplies	Estimate	1	LS	$0.00	$0.00	$250.00	$250.00	$250
Comprehensive Baseline Groundwater Sampling and Analysis								
Labor (2 people, 10 hours/day, 13 days)	33-22-0108	260	HR	$48.58	$0.00	$0.00	$48.58	$12,631
VOC Analysis (21-day turnaround)	33-02-1618	88	EA	$0.00	$0.00	$0.00	$117.78	$10,364
pH Analysis	33-02-1602	75	EA	$0.00	$0.00	$0.00	$7.15	$536
Shipping (13 coolers per event weighing 20 pounds each)	33-02-2042	13	EA	$0.00	$38.60	$0.00	$38.60	$502
Equipment Shipping (assume each piece weights 25 pounds)	33-02-2042	3	EA	$0.00	$48.25	$0.00	$48.25	$145
2" Submersible Pump (Rental)	33-23-0517	3	WK	$0.00	$247.78	$0.00	$247.78	$743
Portable Generator (Rental)	33-01-0503	13	DY	$0.00	$0.00	$0.00	$67.06	$872
pH/DO/Conductivity/Temperature Meter (Rental)	33-02-0571	3	WK	$0.00	$80.22	$0.00	$80.22	$241
Water Level Indicator (Rental)	33-02-0572	3	WK	$0.00	$0.00	$0.00	$68.33	$205
Truck Rental	33-01-0102	13	DY	$0.00	$39.19	$0.00	$39.19	$509
Per Diem	Illinois State Rate	26	DY	$0.00	$0.00	$28.00	$28.00	$728
Lodging	Illinois State Rate	22	DY	$0.00	$0.00	$60.00	$60.00	$1,320
							System Start-up Sampling and Analysis Total:	**$37,000**
							SubTotal	**$325,200**
Piping Installation (% of Fixed Capital Investment)	8%							$26,000
Electrical Installation (% of Fixed Capital Investment)	5%							$16,300
Component Subtotal								$367,500
Construction Oversight	15%							$55,100
Overhead and Profit	25%							$91,900
Contingency	10%							$36,800
Grand Total Construction Costs (Rounded to Nearest $1,000)								**$551,000**

Note

1 Reference Format (##-##-####) is for *Environmental Remediation cost Data - Assemblies*, by RS Means, 2006.
Reference Format (####-###-#### and ## ## ##.## ####) is for *Building Construction Cost Data*, by RS Means, 2007.

Key

EA = Each.		CLF	= 100 linear feet.
MO = Month.		LF	= Linear feet.
LS = Lump Sum.		AC	= Acre.
WK = Week.		SY	= Square Yard.
DY = Day.		SF	= Square feet.
CY = Cubic yard.		MI	= Mile.

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TRANSMITTAL LETTER

To: Mr. Jon Peterson, RPM
U.S. Environmental Protection Agency
Superfund
77 W. Jackson Blvd.
Chicago, Illinois 60604

Date: October 19, 2007
Project No.: 002482.IA08.01
Project: Beloit Corp. RD/RA

Sent by:

- ☐ Mail
- ☐ Air Freight
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- ☐ Under Separate Cover
- ■ Enclosed

Per: Kevin Phillips, E&E Project Manager

Quantity	Item	Description
2 copies	Report	95% Remedial Action Design Analysis Report for Beloit Corporation Site, Rockton, Illinois.

2482IA0801_CHI1117

95% Design Analysis Report

Beloit Corporation Site
Rockton, Winnebago County, Illinois

Illinois EPA ID: L2010355004

Illinois EPA Procurement No.: HWA-8311
Work Order No.: 2

October 2007

Prepared for:

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
Bureau of Land
Federal Sites Remediation Section
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List of Acronyms

1,1,1-TCA	1,1,1-trichloroethane
1,1-DCA	1,1-dichloroethane
1,2-DCA	1,2-dichloroethane
1,1-DCE	1,1-dichloroethylene
1,2-DCE	1,2-dichloroethene, 1,2-dichloroethylene
amsl	above mean sea level
ARARs	Applicable or Relevant and Appropriate Requirements
ASTM	American Society for Testing and Materials
Beloit	Beloit Corporation Blackhawk Facility
BES	Bodine Environmental Services, Inc.
BGS	below ground surface
BLRA	Baseline Risk Assessment
CAC	Corrective Action Contractor
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CHSP	contractor health and safety plan
cm/sec	centimeters per second
COC	chemical of concern
CUO	cleanup objective
DMR	Discharge Monitoring Report
DOJ	United States Department of Justice
EE	engineering evaluation
E & E	Ecology and Environment, Inc.
EEEI	Ecology and Environment Engineering, Inc.
EPA	United States Environmental Protection Agency

List of Acronyms (Cont.)

ESD	Explanation of Significant Differences
FS	feasibility study
FSP	Field Sampling Plan
gpm	gallons per minute
HDPE	high-density polyethylene
HOA	hand/off/auto switch
hp	horsepower
IAC	Illinois Administrative Code
Illinois EPA	Illinois Environmental Protection Agency
I/O	input/output
ISCA	Interim Source Control Action
kVA	kilovolt-ampere
MCLs	maximum contaminant levels
mg/L	milligrams per liter
MW	monitoring well
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	operations and maintenance
OSHA	Occupational Safety and Health Administration
P&ID	Piping and Instrumentation Diagram
P&T	pump-and-treat (system)
PCE	tetrachloroethene, tetrachloroethylene
PLC	programmable logic controller
PRG	preliminary remediation goal
psi	pounds per square inch
PV	pore volume
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
RA	remedial action
RCRA	Resource Conservation and Recovery Act

List of Acronyms (Cont.)

RD	remedial design
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RMS	root mean squared
ROD	Record of Decision
SAI	Source Area Investigation
SDR	standard dimension ratio
site (the)	Beloit Corporation Blackhawk Facility
Soterion	Soterion/United Recovery facility
SOW	Scope of Work
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TACO	Tiered Approach to Corrective Action Objectives
TCE	trichloroethene, trichloroethylene
µg/L	microgram per liter
USGS	United States Geological Survey
VAC	volts alternating current
VDC	volts direct current
VOC	volatile organic compound
WP	work plan

1 Introduction

This document was prepared for the Illinois Environmental Protection Agency (Illinois EPA) under Professional Services Agreement Number HWA-8311, Work Order No. 2, dated June 20, 2007, between Illinois EPA and Ecology and Environment, Inc. (E & E).

Under this work order, E & E was tasked to develop this 95% Design Analysis Report for the Beloit Corporation Blackhawk Facility (Beloit) site located in Rockton, Winnebago County, Illinois. The Design Analysis Report documents the overall management strategy for performing the design, planning the remedial action (RA), and developing a long-term operations and maintenance (O&M) program, pursuant to the final remedy set forth in the Record of Decision (ROD) for the Beloit site (Illinois EPA 2004).

Ecology and Environment Engineering, Inc. (EEEI), E & E's wholly owned, Illinois-licensed engineering subsidiary, developed this document.

The Illinois EPA is the lead agency and the United States Environmental Protection Agency (EPA) is the support agency for this site.

1.1 Purpose of the Design Analysis Report

The purpose of this Design Analysis Report is to compile, for Illinois EPA and EPA review and approval, all functional and technical requirements and all provisions applicable to the remedial action, which include the following:

- Design assumptions and parameters, including technical and functional restrictions based on results of the Source Area Investigation (SAI) and the Interim Source Control Action (ISCA) Engineering Evaluation;
- Design calculations including determination of performance efficiencies for treatment systems' unit processes and equipment;

- Design drawing set showing site and equipment layouts, process flows, and locations of construction activities;

- Requirements for equipment and identification of long-lead procurement items; and

- Identification of the need for additional regulatory agency permits, coordination with outside agencies, site access agreements, and easements.

EEEI has incorporated Illinois EPA and EPA comments on the 30% Design Report submittal (EEEI 2007a) and on the 95% RD into this Design Analysis Report and into the 95% RD Report package. Written responses to comments are provided in Appendix A.

Upon receipt of Illinois EPA comments on the 95% RD and Design Analysis Report, EEEI will incorporate the comments and prepare and submit the final RD documents to Illinois EPA. All RD documents will be comprehensive and complete so that bidding packages can be prepared and provided to remediation contractors. The final RD documents will include all of the 95% RD documentation, revised as agreed upon with Illinois EPA, plus the final cost and construction-related items as follows:

- Final capital and O&M cost estimate;

- Final construction schedule;

- Draft O&M Plan;

- Final construction quality assurance objectives; and

- Substantial requirements for CHSPs.

The final remedial design will be a comprehensive set of specifications designed to meet the cleanup objectives (CUOs) established in the ROD for the Beloit site. Illinois EPA will hold the contract with the selected remedial action contractor(s). The CHSP(s) will be prepared by the remedial action contractor(s) selected to perform the tasks as required by the plans and specifications. The specifications prepared by EEEI will state the requirements of the CHSPs. Additionally, EEEI will finalize the O&M Plan following Illinois EPA comments; however, upon completion of site construction activities by the Illinois EPA Corrective Action Contractor (CAC), Bodine Environmental Services, Inc. (BES), the O&M Plan will require additional review. Additionally, record drawings will be prepared following construction.

This Design Analysis Report is composed of seven sections. Section 1 presents the introduction, purpose, and basis for development of the Design Report. Section 2 summarizes background information about the Beloit site and provides an overview of the existing site conditions. Section 3 delineates the groundwater treatment zones as defined by the SAI, and Section 4 discusses the current treatment system and findings from the ISCA Engineering Evaluation. Section 5 presents the proposed treatment system design, and Section 6 describes additional considerations for the remedial action. Section 7 is a list of the references used in this report.

1.2 Basis for the Design Report

The RA at the Beloit site is based on the Scope of Work (SOW) provided by the Illinois EPA, which ~~was incorporated~~ into E & E's RD Work Plan (WP; E & E 2006). Some of the tasks listed in the WP have been completed under the O&M activities ~~provided by BES~~.

which tasks?

2 Site Background

2.1 Site Description

The Beloit Corporation's Blackhawk Facility (the site) is located in Rockton Township in north-central Illinois. This National Priorities List (NPL, or Superfund) site occupies part of the northern half of Section 13 and the southeast quadrant of Section 12, T46N, R1E, Winnebago County, Illinois.

The site is bounded on the north by Prairie Hill Road, on the west by the Rock River, on the south by a line projected from the Rock River along the south edge of a village of Rockton easement and access road (for the village water tower) to Blackhawk Boulevard, and on the east by Blackhawk Boulevard (Figure 2-1). The NPL site area includes the Beloit Corporation property, the neighboring Blackhawk Acres subdivision, the former Soterion/United Recovery facility (Soterion), a portion of the Taylor, Inc. property, and the Safe-T-Way property.

2.2 Site Geology and Hydrogeology

Regional geology and hydrogeology information was obtained from the ROD and the remedial investigation and feasibility study (RI/FS). Source area geology and hydrogeology information was taken from the Source Area Investigation Technical Memorandum (E & E 2007). The SAI fieldwork was performed in December 2006 and concentrated on characterizing the source area adjacent to the Erection Bay.

2.3 Regional Geology and Hydrogeology

The site is located over the ancestral Pecatonica-Sugar Rivers Bedrock Valley, where it merges with the Rock River Bedrock Valley. The glacial deposits beneath the site consist of a coarse upper outwash, primarily in the vadose zone; a fine-grained middle outwash, typically at or below the water table; and a coarse-grained lower outwash, which is bounded below by a lacustrine clay deposit that extends laterally beneath the site. The shallow aquifer identified at the site consists of the outwash deposits present above the lacustrine clay unit. The depth to groundwater, generally unconfined across the site, is approximately 20 feet. In general, groundwater flow is toward the southwest and south, ultimately discharging to the Rock River south of the village.

The groundwater at the site and within the village of Rockton meets the standards of Title 35 Illinois Administrative Code (35 IAC) Part 620.210 Class I, Potable Resource Groundwater.

The Remedial Investigation (RI) report provides hydraulic conductivity data for the middle outwash deposits estimated from bail-down slug tests conducted in 16 monitoring wells across the site, including wells W23 and W23B at the Erection Bay. Hydraulic conductivities ranged from 1.8E-2 centimeters per second (cm/sec) to 9.6E-6 cm/sec, with a geometric mean of 5.5E-4 cm/sec. At the Erection Bay, hydraulic conductivities for W23 and W23B were reported as 6.8E-3 cm/sec and 1.0E-4 cm/sec, respectively.

2.4 Source Area Geology and Hydrogeology

Glacial deposits beneath the Erection Bay consist of a coarse upper outwash, primarily in the vadose zone, and a finer-grained middle outwash, typically at or below the water table. Soil materials observed in boreholes from the SAI were generally consistent with the geologic conditions observed and reported in the RI report.

From the ground surface to 20 to 25 feet below ground surface (BGS), the upper outwash consists primarily of poorly sorted, well-drained, fine to coarse sand and fine to coarse gravel with occasional laterally discontinuous silty sand and silt intervals. Cobbles are frequently encountered in the upper outwash. This unit was difficult to penetrate with the drill rig due to the cobbles and the tendency for collapse, resulting in loose and unconsolidated cores.

The upper outwash is underlain by the finer-grained middle outwash observed at a depth of 20 to 25 feet BGS and consisting of a very dense, brown to yellow-brown sandy silt, interbedded with occasional thin sand, gravel, or silt seams. The middle outwash is observed to a depth of 50 to 55 feet BGS. Retrieved soil core materials were typically highly consolidated, with a cemented matrix. Occasional horizontally oriented fractures were observed.

The water table was measured in the middle outwash in monitoring well W23 at a depth of approximately 26 feet BGS. Groundwater was rarely observed in a borehole during drilling, however, suggesting that the middle outwash below the Erection Bay is a relatively lower-conductivity zone than other areas south of the Erection Bay. Groundwater flow in the middle outwash appears to be primarily by fracture flow.

Analysis of drawdown data from the pumping test at EW01, using wells W23 and W23B as observation wells, was performed during the SAI. The estimated hydraulic conductivity calculated from this test was 7.6E-4 cm/sec. Extraction well recovery data yielded a calculated hydraulic conductivity value of 2.2E-4 cm/sec. Both of these pump test hydraulic conductivity values are similar to the geometric mean value calculated from the RI data (5.5E-4 cm/sec). This suggests that the geometric mean value is a good estimator of the hydraulic conductivity for the middle outwash in the Erection Bay area.

2.5 Site History

The manufacturing facility formerly owned by the Beloit Corporation comprises the majority of the site. The Beloit Corporation is a former manufacturer of machines that produced layered paper products from paper pulp. The use of solvent for machine parts cleaning at the Beloit Corporation plant was identified as the source of groundwater contamination.

In June 1999, the Beloit Corporation filed for bankruptcy. In February 2002, EPA, the United States Department of Justice (DOJ), and Guiffre II, LLC, the new owner of the property located within the Beloit Corporation site, signed a settlement agreement under Section 122(h) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The State was also a party to and signed the agreement in April 2002. The new property owner uses the site as a transfer station for drywall and other building materials.

2.6 Summary of Previous Site Investigations

In the early 1980s, the Illinois EPA investigated United Recovery and private water supply wells located in the Blackhawk subdivision. The discovery of volatile organic compounds (VOCs) [primarily tetrachloroethene (PCE) and 1,1,1-trichloroethane (1,1,1-TCA)] in residential groundwater led to subsequent groundwater quality studies and the inclusion of the Beloit Corporation site on the NPL. Pursuant to a consent decree, the Beloit Corporation was required to complete an RI/FS, which included the Beloit Corporation property.

During the RI, soil, soil gas, and groundwater quality data was gathered by Montgomery Watson Americas, Inc., consultant to the Beloit Corporation (Montgomery Watson 1999). Because of elevated concentrations of PCE in groundwater from monitoring wells W23/W23B and W36C and in vicinity soils, the southern area of the Erection Bay is believed to be the source area for the On-Property Groundwater Plume. High levels of PCE in groundwater have been persistent at this location, despite implementation of the ISCA pump-and-treat system and placement of an extraction well (EW01) in the vicinity. In the RI report, Montgomery Watson estimated the dimensions of the Erection Bay source area (groundwater VOCs in excess of 1,000 micrograms per liter [μg/L]) to be approximately 100 feet by 120 feet (12,000 square feet), and conservatively estimated that the plume in this area extends to a depth of 60 feet BGS.

Based on the RI, the Illinois EPA determined that the VOC contamination of groundwater originates on the Beloit Corporation property and extends via a plume into the Village of Rockton and the southern portion of the Blackhawk Acres subdivision. A second plume, containing trichloroethene (TCE) and located deeper within the shallow aquifer, originates near the southeast corner of the Beloit Corporation property and extends into the village of Rockton. The source of the TCE plume could not be identified.

A Baseline Risk Assessment (BLRA) was conducted by the Beloit Corporation with oversight by the Illinois EPA. The Illinois EPA conditionally approved the BLRA in December 2000, and Beloit Corporation submitted the final BLRA, with requested revisions, in January 2001.

Based on the RI and BLRA, chemicals of concern (COCs) at the Beloit Corporation NPL site are chlorinated VOCs in groundwater and soil. The VOCs in groundwater on and around the site are distributed into three plume categories that incorporate the five separate areas of VOCs identified in the RI report. These three plume categories are as follows:

- **Groundwater VOC Source Area** – On the Beloit Corporation property near the current location of the Erection Bay.
- **On-Property Groundwater Plume** – On the Beloit Corporation property. This plume includes all the VOC-contaminated groundwater detected in the central portion of the Beloit Corporation property.
- **Off-Property Groundwater Plumes** – Off the Beloit Corporation and NPL site boundaries. This off-property area includes the following groundwater plumes and areas of VOC groundwater contamination, as described in the RI:
  - TCE plume;
  - That portion of the On-Property Groundwater Plume that extends south of the NPL site into the Village of Rockton; and
  - Southern Blackhawk Acres subdivision wells.

In November 2001, the final feasibility study (FS) that discusses and compares the potential cleanup remedial alternatives was completed by the Beloit Corporation. The Illinois EPA conditionally approved the final FS in January 2002.

2.7 Previous Remedial Actions

In 1993, the Illinois EPA installed point-of-entry carbon filtration units in residences with impacted wells in the Blackhawk Acres subdivision. The Illinois EPA currently maintains and monitors these systems. The ISCA pump-and-treat system was installed in 1996 by Beloit Corporation, with the approval of the Illinois EPA. The system consists of four extraction wells and an air-stripping tower located in the southeastern corner of the Beloit Corporation property. The system is designed to contain groundwater within the Beloit Corporation property and provide treatment of extracted groundwater by air stripping. Treated groundwater is discharged to the Rock River under a National Pollutant Discharge Elimination System (NPDES) permit, at an outfall located on Beloit property. The VOC groundwater plumes in the Village of Rockton and the Blackhawk Acres subdivision have been naturally attenuating since the ISCA pump-and-treat system was implemented.

BES, a State Procured Corrective Action Contractor, is responsible for long-term groundwater monitoring and O&M associated with the existing ISCA pump-and-treat system. Groundwater monitoring is performed quarterly pursuant to the Action Memorandum for the ISCA and the Removal Action Design Report, both of which are part of the Administrative Record for the site.

2.8 Scope of the Final Remedial Action

The final ROD for the Beloit Corporation site was signed in September 2004. The selected remedial action contained in the ROD is a final, sitewide remedy that addresses the groundwater and soil contamination at the site. The ROD specifies that the primary remedy for the site is the existing ISCA pump-and-treat system, which is to be augmented by chemical oxidation of groundwater and soil in the Erection Bay source area, and the installation of additional extraction wells, as necessary. The ROD requires institutional controls to prohibit the installation of potable water wells on Beloit Corporation property until the groundwater is restored to the more stringent of either the federal maximum contaminant levels (MCLs) or State of Illinois Class I groundwater standards for all COCs.

Additionally, monitored natural attenuation of groundwater in the Blackhawk Acres subdivision and in the Village of Rockton is to be performed until the more stringent of either the MCLs or State of Illinois Class I groundwater standards is achieved for all COCs. Groundwater at the Erection Bay and any contaminated soils associated with the source area constitute the principal threats at the site.

In December 2006, pursuant to the ROD, soil and groundwater below and in the vicinity of the Erection Bay were investigated to delineate the area where groundwater VOC concentrations were the highest. This data was to be used to develop a work plan for a chemical oxidation pilot test.

However, results from the SAI identified several factors that mitigated against the implementation of chemical oxidation as a treatment tool for the source area. These factors were reported to the Illinois EPA in a Technical Memorandum (E & E 2007) and include:

- **Extent of the Source Area.** The SAI identified a source area (i.e., an area where groundwater total VOC concentrations are approximately 500 µg/L, or more) that is approximately five times larger than the source area delineated in the RI and evaluated in the FS report. Figures 2-2 through 2-4 show the source area plume size and concentrations for PCE, TCE, and cis-1,2-dichloroethylene, respectively.

- **Soil Conditions in Source Area.** Source area soils were found to be highly consolidated and extremely dense with relatively low permeability, which would make the introduction of an oxidant difficult and would result in poor oxidant transport and decreased efficiency and effectiveness.

- **Potential Cost Increase.** Cost increase due to the increased plume size and multiple injections required to meet cleanup objectives could drive the cost to six times the estimated cost presented in the FS.

Given the results of the SAI, and the factors described above that potentially could inhibit implementation of chemical oxidation, E & E evaluated other technologies that might be viable for addressing the source area. Several technologies were eliminated in the FS report and were not considered further by E & E. These included slurry walls, passive wall treatment, and thermal vapor extraction. Soil vapor extraction (SVE) was screened out due to the lack of VOCs in the vadose zone. Air sparging and dual-phase vapor extraction were considered but eliminated due to some of the same issues surrounding chemical oxidation, i.e., the need for numerous injection/extraction points, poor contact between injected/extracted air and matrix contaminants, and significant infrastructure requirements (piping, blowers, etc.) that could impact facility operations. Enhanced biodegradation was similarly eliminated due to the need to inject substrate for microorganisms, or other solutions to control subsurface redox conditions, and the potential for the generation of vinyl chloride.

The remaining viable technology for the source area was determined to be groundwater extraction and treatment, i.e., the construction of one or more additional extraction wells in the source area and pumping the water to the existing ISCA air stripper. Potential operational and administrative benefits of this approach included:

how many?

- The existing air stripper on site has proven to be effective, has the capacity to accommodate additional extraction wells, and has low additional capital costs and a low operating cost.
- Construction of additional extraction wells would cause minimal impairment of ongoing facility operations.
- To increase the effectiveness of additional extraction wells, hydraulic fracturing of well boreholes could be performed prior to well installation, and pulsed-pumping schedules could be employed to maximize the removal of VOCs.
- The ROD included contingency provisions for the construction of additional extraction wells.

how much?

Because of these factors, E & E recommended that the Illinois EPA move forward with the design of additional extraction wells for the Erection Bay source area, in lieu of chemical oxidation. Following review of the SAI Technical Memorandum, the Illinois EPA and EPA concurred. Currently, an Explanation of Significant Differences (ESD) is being prepared to document this change to the ROD.

was signed on ____.

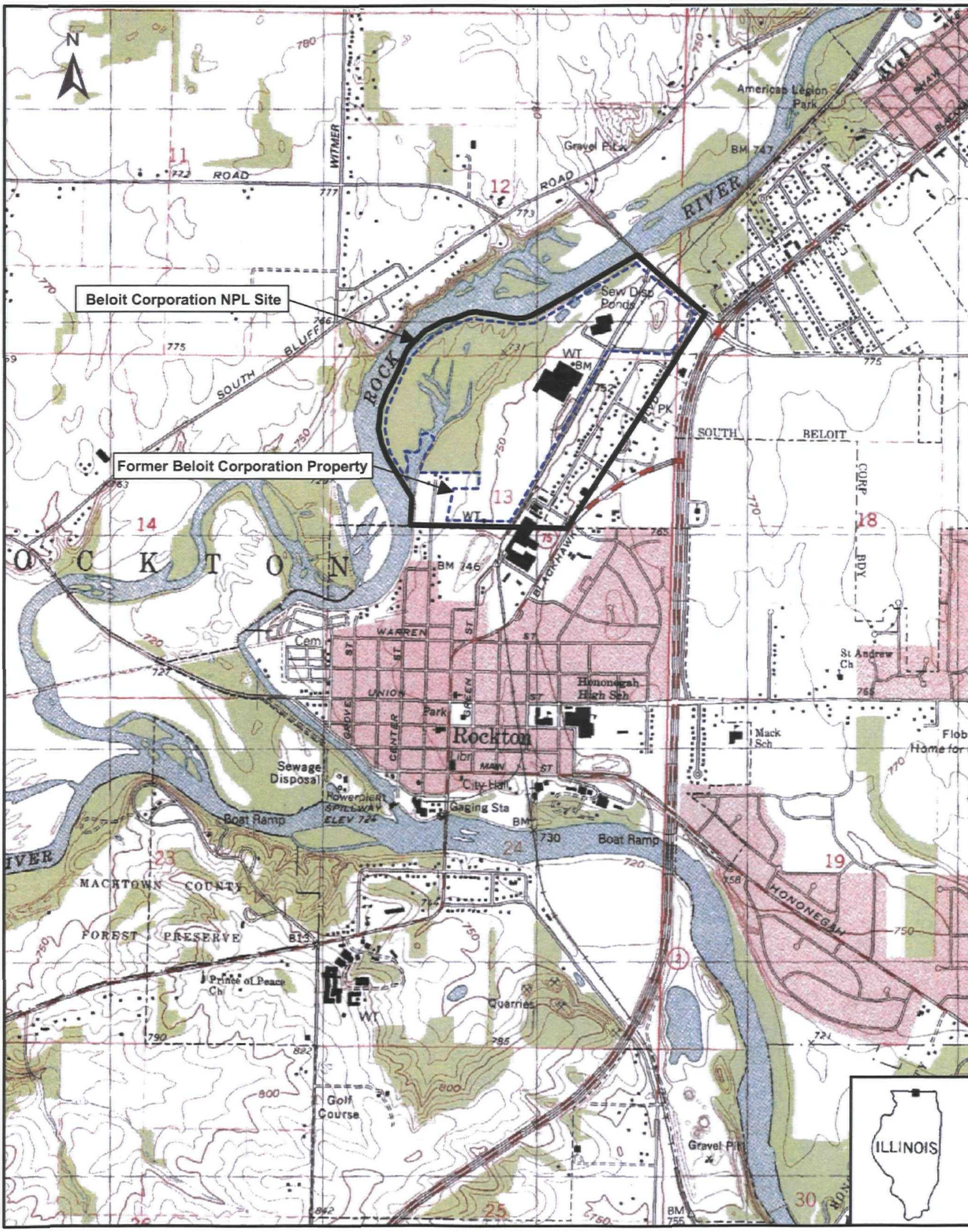

Figure 2-1
Site Location Map, Beloit Corporation Site

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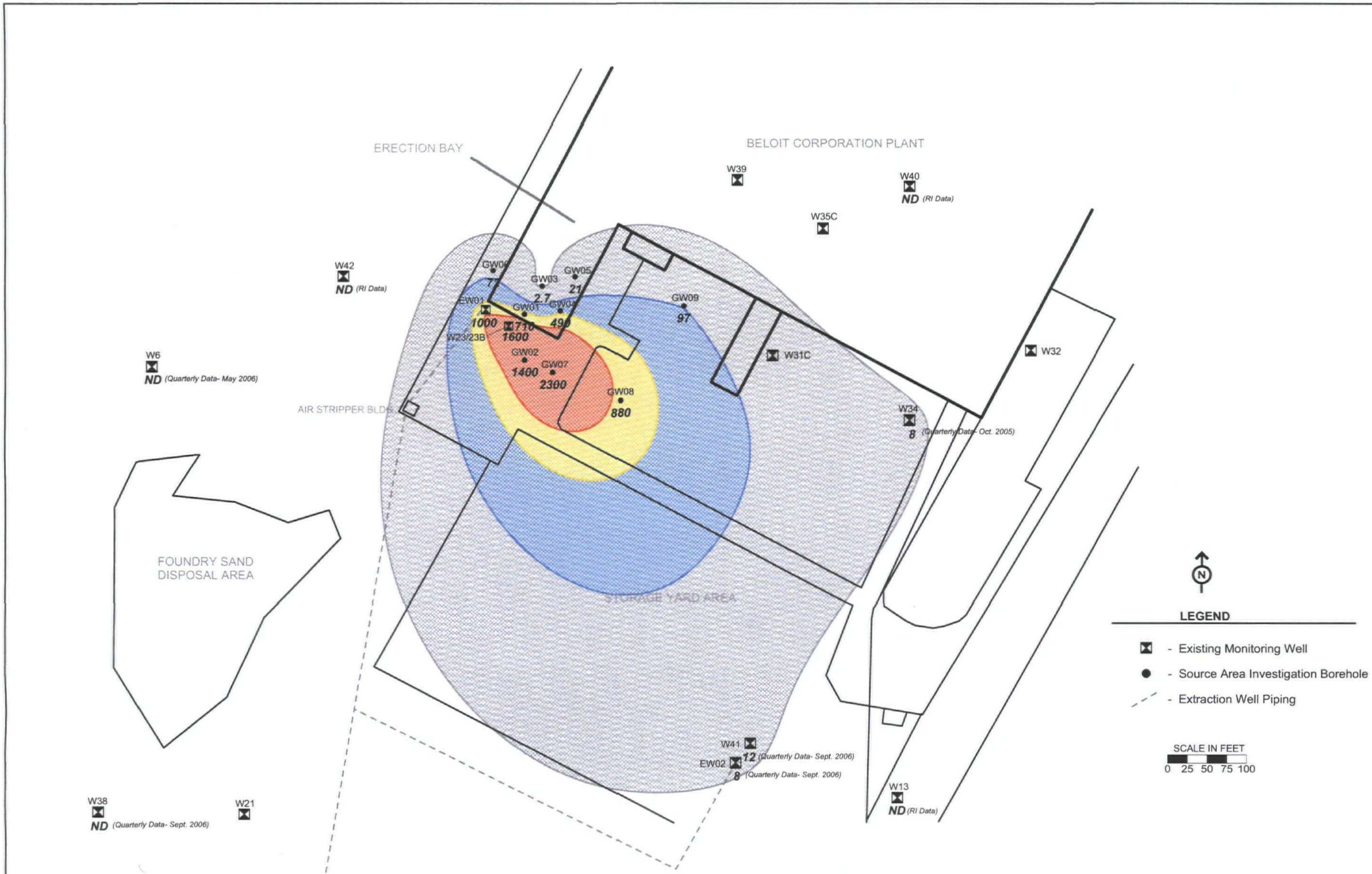
Source: U.S.G.S., South Beloit, Il-Wis 7.5' Quadrangle, 1993.



ecology and environment, inc. International Specialists in the Environment		Figure 2-2 EXTENT OF PCE CONCENTRATIONS, SOURCE AREA INVESTIGATION
DESIGNED BY	CHECKED BY	Beloit Corporation NPL Site
DRAWN BY	APPROVED BY K. Phillips	SCALE See Figure; DATE 2/2/2007; FILE NO.; DRAWING NO.; REV. 0

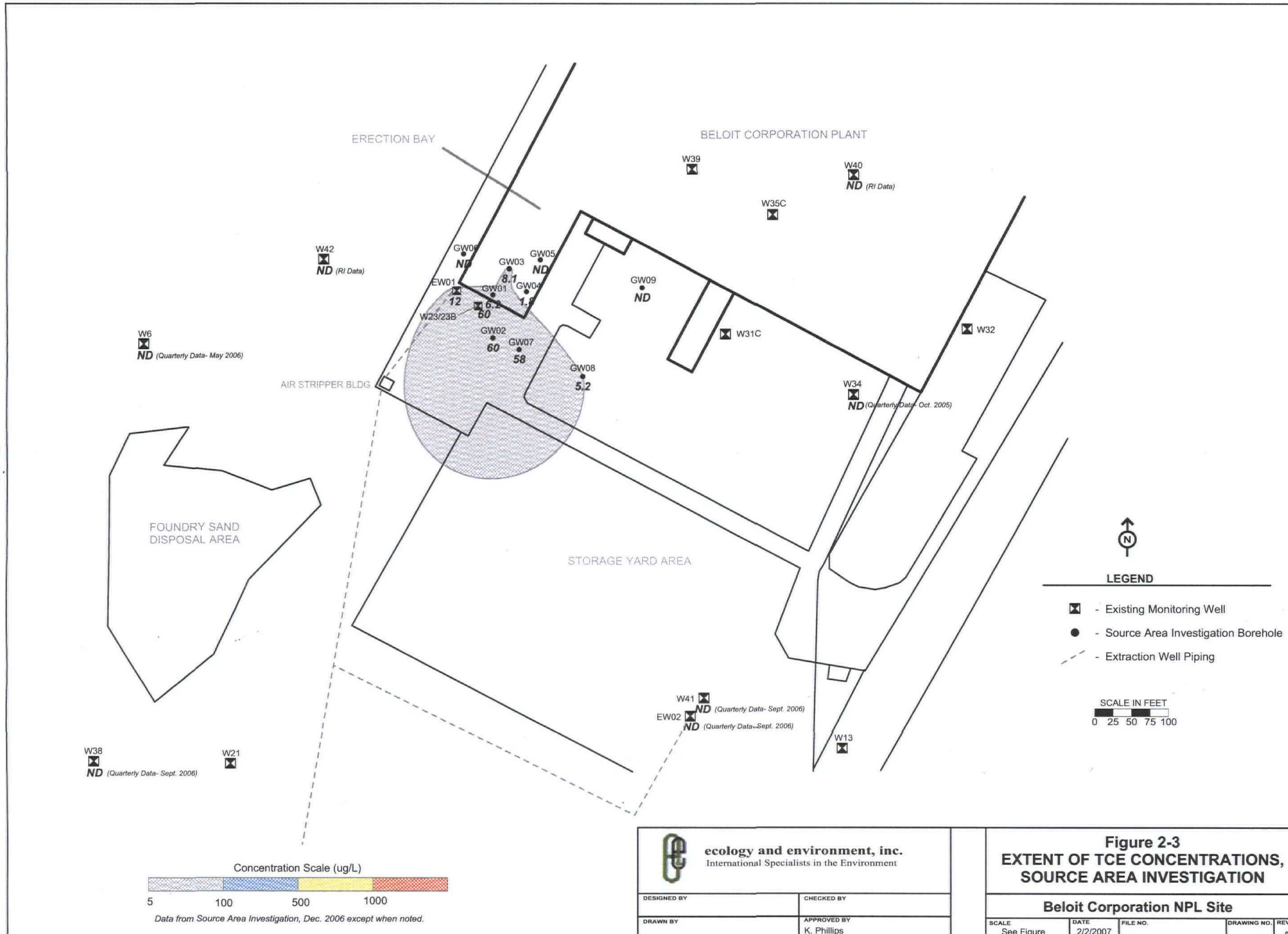


Figure 2-3
EXTENT OF TCE CONCENTRATIONS, SOURCE AREA INVESTIGATION
Beloit Corporation NPL Site

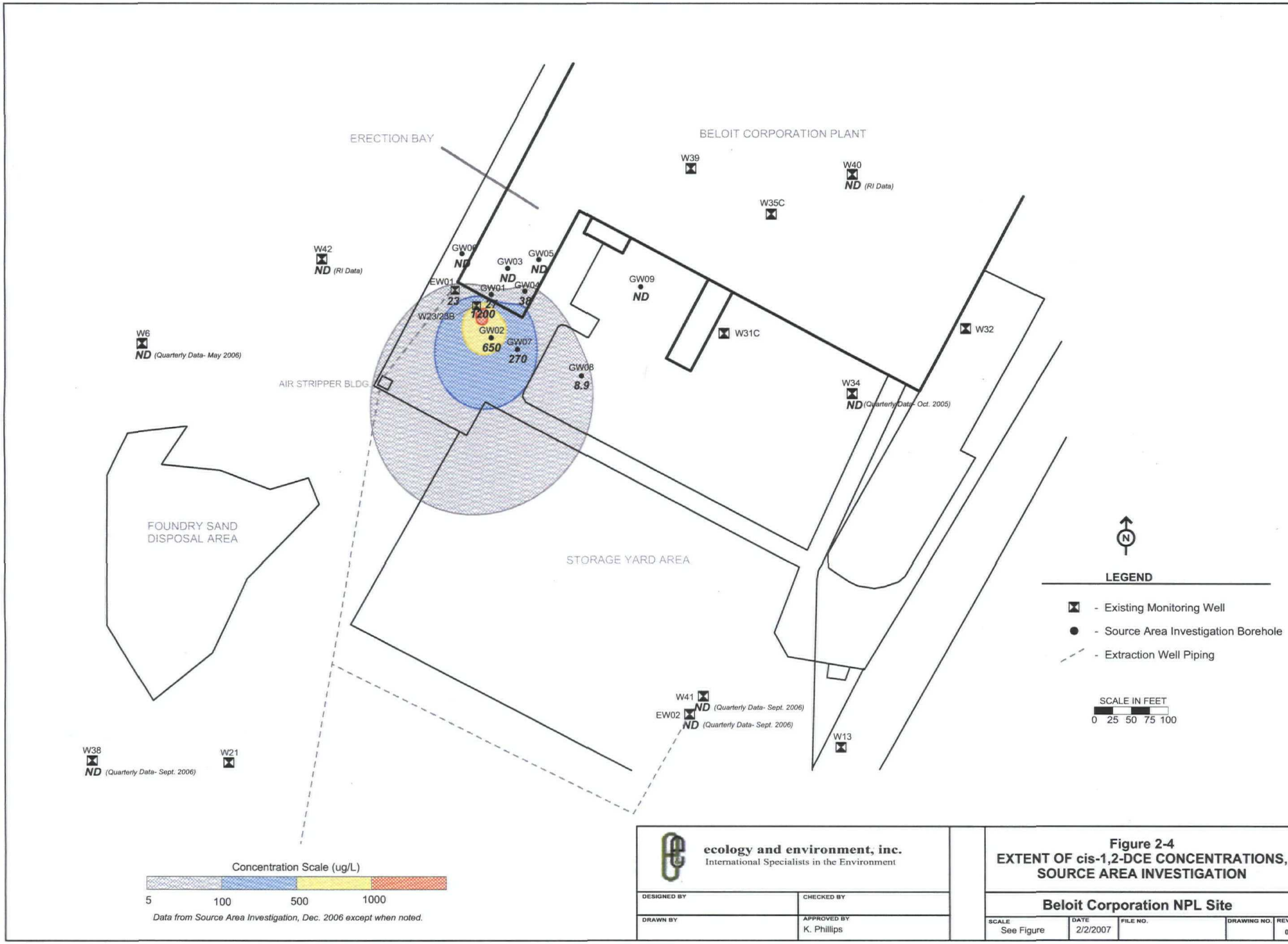


Figure 2-4
EXTENT OF cis-1,2-DCE CONCENTRATIONS, SOURCE AREA INVESTIGATION

Beloit Corporation NPL Site

3 Groundwater Treatment Zone Delineation and Well Layout

Past reports have documented the migration of VOCs released from the vicinity of the Erection Bay, along with groundwater, to the southwest, essentially parallel to the river. The natural discharge area for groundwater originating on the Beloit property would be the Rock River south of the village. However, the ISCA pump-and-treat system has been capturing this groundwater. VOCs within the capture zone of the ISCA pump-and-treat system are removed and treated by air stripping.

The SAI was conducted to determine the vertical and horizontal extent of the source area contamination in an effort to develop a remedial plan that would reduce operating time of the pump-and-treat (P&T) system. SAI activities included groundwater sampling, vadose-zone soil sampling, surveying, water level measurements, and an existing monitoring well survey. In general, all procedures were conducted in accordance with the Illinois EPA-approved Work Plan, Field Sampling Plan (FSP), and Quality Assurance Project Plan (QAPP) documents prepared by E & E (E & E 2006). The QAPP was also approved by EPA. The findings of the SAI were reported in the document, Technical Memorandum for Source Area Investigation (E & E 2007).

Data on groundwater quality within the Erection Bay source area was collected from existing monitoring wells and from nine borehole locations. Three boreholes were located in areas outside the RI-defined source area based on unanticipated results obtained during the field-screening activities. In order to determine the presence of contamination in the vadose-zone soils within the Erection Bay source area, vadose-zone soil samples were also collected.

The SAI identified a source area (i.e., an area where groundwater total VOC concentrations are approximately 500 µg/L, or more) that is approximately five times larger than the source area delineated in the RI and evaluated in the FS report (Figure 3-1). The FS considered a source area with dimensions of 100 feet by 120 feet (an oval-shaped area of 10,000 square feet). The redefined source area identified during the SAI consists of an oval-shaped area approximately 300 feet by 225 feet (i.e., 54,000 square feet).

There was a lack of chlorinated VOCs detected in vadose-zone soils sampled during the SAI. This finding is consistent with results from the RI. Observations of soil cores taken during the SAI and the SAI analytical results suggest that there is little or no residual vadose-zone soil source contributing to VOCs in groundwater at the Erection Bay. Therefore, the proposed treatment area for the remedial design is the source area groundwater only.

The results presented in the *Technical Memorandum for Source Area Investigation* (E & E 2007) are the primary basis for the design of the groundwater P&T system extension into the Erection Bay source area. Site-specific field data from other reports, including the *Remedial Investigation Report* (Montgomery Watson 1999) and *Quarterly ISCA Status Reports* prepared by Montgomery Watson, Sigma Environmental Services, and BES, were also used to evaluate the current system and design the extension. To simulate potential pumping rates and capture zones for the proposed P&T extension, a groundwater flow model was utilized. Guidance documents, including *Design Guidelines for Conventional Pump and Treat Systems* (EPA/540/S-97/504) and *Standard Guide for Application of a Ground-Water Flow Model to a Site-Specific Problem* (ASTM D 5447-93) were also consulted during the design evaluation.

The procedure for applying the groundwater model included the following steps: define study objectives, select a computer code, construct the groundwater flow model, calibrate the model and perform sensitivity analysis, make predictive simulations, and document the process. Each of these steps is described below.

3.1 Study Objectives

The objective for the P&T extension into the Erection Bay source area involves optimizing well locations and extraction rates to maintain effective hydraulic capture within contamination zone(s), minimizing stagnation zones, and maximizing pore volumes pulled through the system, in order to reduce contaminant concentrations to cleanup standards (the more stringent of MCLs or Illinois Class 1 standards), maximize mass removal, and minimize cleanup time and cost. Using the delineation of Erection Bay contaminant areas described in the Technical Memorandum (Figure 3-1), a capture zone analysis was performed to optimize the P&T design. The analysis allowed evaluation of alternative extraction schemes, and visualization of groundwater path lines and contaminant particle travel times from capture to extraction and treatment.

3.2 Model Selection

The software used was FLOWPATH II (Version 1.1), developed by Waterloo Hydrogeologic Inc. FLOWPATH II is a two-dimensional, finite difference, groundwater flow, path line, and contaminant transport modeling package. An earlier version of this software was used in design of the existing ISCA P&T

system. The earlier model results were reported in the Removal Action Design Report (Montgomery Watson 1996a).

3.3 Model Construction

Groundwater flow model construction involves the process of transforming important aspects of the physical hydrogeologic system being modeled into mathematical form. Building the model in FLOWPATH II required a base map, definition of a two-dimensional finite difference grid, well locations, aquifer properties, head boundary conditions, and observation points for model calibration. The following is a description of the model input parameters and a discussion of the rationale for the selection of those parameters.

Unit System: English units (ft/gal/day).

Base Map: The base map for the modeled area was obtained by digitizing portions of Drawing No. F5 from the RI Report, which was developed from an aerial survey performed in November 1990. Consistent with the RI Report, the Illinois State Plane Coordinate System and U.S. Geological Survey (USGS) elevation datum were applied to the model base map.

Grid Parameters: The model grid is 83 columns by 58 rows (Figure 3-2). The grid spacing is based on 40-foot grid nodes, with nodes refined to 10 to 20 feet around existing extraction wells and proposed new wells.

Observation Wells: Nine monitoring wells were selected from the model area to serve as observation wells and to provide points for matching observed versus calculated heads during model calibration. Average water table elevations measured at each well location prior to installation of the ISCA were used as the observed heads, with the objective of calibrating the model to pre-pumping flow conditions around the Erection Bay. Water table elevations used in the model were taken from the RI Report and are provided in Table 3-1 and shown on Figure 3-7. No extraction wells were included in the calibration run.

Aquifer Properties: Two different aquifer property zones were defined throughout the model. These zones and values are shown on Figure 3-3. To define the zones, bail-down slug test data and geologic cross-section information provided in the RI Report were evaluated for each monitoring well located in the model area. When the RI conductivity data was mapped, it was observed that a zone of higher hydraulic conductivity (i.e., Zone 2, which was one to two orders of magnitude greater) exists along the south and east boundaries of the model area. Wells in this area, with the exception of well W32, were identified in the RI as screened in the coarse upper outwash. The coarse upper outwash is composed mainly of coarse sand and gravel. The geometric mean value for conductivity in Zone 2, based on slug test data, was calculated to be 19 feet/day. A value of

10 feet/day was used in the final calibrated model. Conductivity values in Zone 1 were significantly lower, and correspond to the fine middle outwash defined in the RI Report. The fine middle outwash is predominantly silty sand and silt and has a calculated geometric mean conductivity value of 1.6 feet/day. These aquifer materials and conductivity values were confirmed during the SAI. A pumping test conducted in extraction well EW01 located at the southwest corner of the Erection Bay and screened in the fine middle outwash resulted in a calculated hydraulic conductivity value of 2.1 feet/day. A value of 2.0 feet/day was used in the final calibrated model.

The porosity assigned to each zone is the effective porosity, which is defined as the volume of aquifer material divided by the volume of interconnected pore space available for groundwater to flow. This is always less than the total porosity. A lower effective porosity value of 0.1 was assigned to Zone 1 compared to Zone 2 (0.2) due to the prevalence of silt in Zone 1 aquifer materials.

Aquifer Bottom Elevations: The aquifer bottom elevation was designated as the top of the extensive clay unit identified during the RI at a depth of between 60 and 80 feet below the model area. Three zones were blocked out to represent the elevation of a thin clay ridge (690 feet above mean sea level [amsl]) and two transition zones surrounding the ridge (680 and 670 feet amsl). The various bottom elevation zones incorporated into the model are shown in Figure 3-4.

Boundary Conditions: The Erection Bay source area is situated in a complex flow field that is significantly influenced by the Rock River, the downstream hydroelectric plant dam/spillway, and a northeast-to-southwest-trending groundwater high located north and west of the Beloit Corporation facility. Figure 3-5 shows the model area superimposed on pre- and post-ISCA water table maps. These maps demonstrate the persistent effect of the groundwater high and the Rock River on the flow field, regardless of ISCA pumping, and the general groundwater contours the model was designed to simulate. Specifying the boundary conditions of the groundwater flow model included assigning a boundary type to every point along the boundary surface of the aquifer system and to internal sources or sinks, in order to simulate the observed flow field.

The Rock River is typically a groundwater discharge area along its length. However, the dam on the Rock River in the village controls the relationship between surface water and groundwater in the area of the pool behind the dam. Where the head in the pool is greater than the head in the groundwater system, surface water is induced to flow from the river into the aquifer. This effect extends upriver to approximately the mid-point of the model area around monitoring wells W6 and W38. These wells represent an inflection point in the flow field where regional groundwater flow toward the river is turned away from the river due to head pressure of the pool.

The groundwater high north and west of the Erection Bay is a divide between flow to the Rock River, to the northwest, and to the Rock River below the dam south of the Village. The groundwater high is maintained by rainfall recharge to the aquifer, regional flow into the area, and the pool upstream of the dam. The groundwater high is consistently observed in monitoring well W42, immediately west of the Erection Bay, and in well W40, north and east of the bay, where an elevated water table is routinely measured. The groundwater high causes a slight southeasterly direction of flow through the Erection Bay source area, before a more south/southwesterly flow develops downgradient in the Storage Yard Area.

To simulate the observed flow, a combination of constant head and river nodes were required in the model (Figure 3-6). River nodes were designated along the western boundary to simulate the Rock River and the backwater areas west of the Erection Bay. The heads assigned to the river nodes were based on average elevations from staff gages reported in the RI. The river bed elevations were designated to maintain a constant 8-foot river depth along the length of the river. The leakage factor assigned to the river bed was taken from the Removal Action Design Report (Montgomery Watson 1996a), and determined by model calibration runs.

Constant head nodes were required to simulate the persistent groundwater high/divide located north and west of the Erection Bay. Along the east and south boundaries of the model area, constant heads nodes were required to simulate the observed flow field. These artificial conditions on the grid boundary did not significantly impact the predictive capabilities of the model in the area of interest around the Erection Bay. Head values used for the constant head nodes were taken from average water table elevations measured prior to ISCA operation (Table 3-1) and reported in the RI.

Areal Recharge: An infiltration rate of 4 inches per year was assumed based on an average percolation rate through non-sloping vegetated land in the Midwest region of the United States. This value was also used in design of the ISCA P&T system.

Aquifer Type: Unconfined.

3.4 Model Calibration

Calibration of the groundwater flow model was performed by trial-and-error adjustments to hydraulic parameters, boundary conditions, and initial conditions within reasonable ranges to obtain a match between observed and simulated flow potentials. The Pre-ISCA Average Water Table Map (Figure 3-7) and the general flow configurations shown in Figure 3-5 were used as the basis for calibration. The final calibration run for the modeled area is shown in Figure 3-8. Calibration was evaluated through analysis of residuals. A residual is the difference between the observed and simulated head at a given location. Observed heads from eight water table well locations on the Average Water Table Map (Figure 3-7) were compared to model calculated heads by using a calibration routine in the FLOWPATH II software. The comparison is graphically presented on Figure 3-8. The mean error for the final calibration run was 0.001109 feet, and the root mean squared (RMS) error was 0.6504 feet. The low RMS value indicated that the model has been calibrated within reasonable tolerances.

The global water balance was also used to evaluate the validity of the simulation. A global water balance was calculated in FLOWPATH II after running the flow model. The water balance function computes all fluxes into and out of the model domain caused by pumping, recharge, leakage, and boundary conditions. To maintain continuity under steady-state conditions, the sum of all fluxes should be equal to zero. The validity of the converged model solution is best when the global water balance is small. Typically, the maximum acceptable water error balance should be less than 1% to 3%. For the final calibration run, the total mass balance error was -0.001670% (Figure 3-8).

3.5 Sensitivity Analysis

Because the aquifer system being modeled is heterogeneous, there is uncertainty inherent in the representation of complex and variable geologic and hydrologic conditions with a finite mathematical model. Sensitivity analysis was used in the calibration process to identify those parameters that are the most important to model reliability. The purpose of the sensitivity analysis was to identify the uncertainty in the calibrated model caused by uncertainty in the estimates of aquifer parameters and other inputs. All geologic and hydrologic inputs, e.g., lithology, thickness, continuity, hydraulic properties, water sources, and sinks, were considered to have some degree of uncertainty; however, the parameters selected for sensitivity analysis were those that would have the greatest effect on potential changes in hydraulic head and the ability of the model to simulate the physical hydrogeologic system. Although all input parameters were varied to some degree during the trial-and-error calibration of the model, the primary parameters identified for sensitivity analysis were the hydraulic conductivity, rainfall recharge, and river bed leakage.

The sensitivity analysis for hydraulic conductivity (increased one order of magnitude and decreased one-half order of magnitude) was performed for Zone 1, where the mass of contaminants requiring cleanup occur. Increasing the hydraulic conductivity value one order of magnitude in Zone 1 resulted in minor deviations from observed groundwater levels, but an increase in the RMS value of approximately 16% and a slightly greater total water balance error. Decreasing the hydraulic conductivity in this zone resulted in groundwater levels significantly different than observed conditions and an RMS value approximately 39% higher than the calibrated value. This indicated that the actual area-averaged conductivity in Zone 1 could be slightly higher, but is unlikely to be lower than the value used in the model. However, the calibrated model value provided a reasonable balance of residuals, RMS error, and water balance error values.

The sensitivity analysis for increasing recharge resulted in flooding the system and calculated heads that did not reflect observed groundwater levels. Therefore, it is unlikely that an increased rainfall recharge scenario is present. Reduction of rainfall recharge by one-half order of magnitude resulted in negligible differences, indicating that minor fluctuations in seasonal recharge would have limited impact on the predictive abilities of the model.

Increasing or decreasing the river bed leakage value within the selected range of values had little to no effect on the model simulations.

3.6 Evaluation of Existing ISCA P&T System at Erection Bay Source Area

To evaluate the effectiveness of the existing P&T system in the Erection Bay source area, extraction wells EW01 and EW02 were incorporated into the calibrated model. Figure 3-9 shows the approximate capture zones for PCE that have developed around EW01 and EW02 since the ISCA was implemented in July 1996. The pumping rate for EW01, 10 gallons per minute (gpm), was based on rates recorded during weekly inspections. This rate was time-averaged to take into account the pulsed-pumping scheme (daily 10 to 15 gpm for 20 hours, followed by 4 hours down) and significantly longer periods when EW01 was down due to O&M issues. In the model domain, drawdown in extraction well EW01 was 18.05 feet during simulated pumping at a time-averaged rate of 10 gpm. This is comparable to an actual drawdown of 19.3 feet measured in EW01 while pumping at approximately 16 gpm during the Source Area Investigation short-term pump test (E & E 2007).

The pumping rate for EW02, 15 gpm, was similarly time-averaged to account for fluctuations in recorded pumping rates, and down periods. Extraction well EW02 is not pulse-pumped.

The capture zones for the two extraction wells illustrate several issues that lead to low system effectiveness:

- Low pumping rates lead to limited capture zones. Complete capture of the Erection Bay source area plume has likely not been achieved, even after approximately 10 years of pumping. Low hydraulic conductivity around EW01 and unanticipated down time due to property transfer and O&M issues are contributing factors. The cause of low rates in EW02 (designed to pump

25 gpm) is unknown, but is being investigated by the O&M contractor (Bodine Environmental Services).

- Inadequate location of EW01. The original objective for the ISCA system was to initiate contaminant mass removal while containing groundwater within the Beloit property boundaries. Now that the Erection Bay source area plume has been shown to be larger than anticipated and oriented in a south-easterly direction, the location of EW01 is inadequate for efficient plume removal.
- Extraction well EW01, placed at the contaminant area perimeter, withdraws a large volume of clean groundwater from beyond the plume via flowlines that do not flush the contaminated zone. While operating, EW01 withdraws less than half of its incoming water from a contaminated zone (Zone A, see Figure 3-9), likely resulting in an effective withdrawal rate of only 5 gpm. Similarly, well EW02 withdraws groundwater from areas outside the contaminated zone, thereby reducing its effective withdrawal rate to approximately 10 gpm.

Restoration of the aquifer requires that sufficient groundwater be flushed through the contaminated zone to remove both existing dissolved contaminants and those that will continue to desorb from porous media and/or diffuse from low-permeability zones. To further asses the existing P&T system in the Erection Bay source area, the times required to pump one pore volume (PV) of groundwater from the source area contaminated zone, and estimates of the number of PVs needed for cleanup were calculated (EPA/540/S-97/504). Table 3-2 provides the estimated pore volumes required to flush the contaminated zones and the minimum time required to reach cleanup (e.g., MCL for PCE [5 μg/L]), given the effective withdrawal rates of 5 gpm for EW01 and 10 gpm for EW02. From this table, it is obvious that the time required under current conditions may be extensive, ranging up to 68 years. It should be noted that this analysis may generally oversimplify the complex site conditions, and uncertainties surrounding the actual average contaminant concentrations and the minimum number of pore volumes required would have an effect on the result of the time frame calculation. However, it provides an indication that improvements to the current system are required for the Erection Bay area.

A particle tracking routine in the FLOWPATH II software was used to evaluate capture of PCE under steady-state (maximum time) conditions. In Figure 3-10, particles were placed at the perimeter of the outermost contaminated zone (Zone C), and allowed to travel under current pumping conditions. The results of this model run suggest that some portions of the contaminated zone are never captured by extraction well EW01 or EW02. Although these particles are likely captured by well EW03, located further downgradient of the Erection Bay (not part of the model), additional time is required for this travel to occur and ultimately contributes to prolonging the remediation time frame.

3.7 ISCA Extension into the Erection Bay Source Area

The calibrated model was used to examine alternative extraction well schemes in the Erection Bay area. The FLOWPATH II model allows the graphical addition and deletion of pumping and observation wells and the ability to edit their location, pumping rates, and observed head values. By trial-and-error adjustment of the number of extraction wells, their location, and various trial pumping rates, an optimum configuration of extraction wells in the Erection Bay source area was determined. Multiple simulations were run with the objective of maximizing pore volumes pulled through the system (maximize pumping rates), minimizing stagnation zones between extraction wells, and achieving quick capture of the contaminant mass.

A combined source control, mid-plume, and downgradient pumping scheme was determined to be optimal in reducing the flow path and travel times of contaminants to extraction wells. Under this configuration, extraction well EW01 was no longer utilized, but a replacement well, EW05-NEW, was positioned at the opposite corner of the Erection Bay, closer to the center of contaminant mass in the most contaminated zone (Zone A). Two new extraction wells, EW06-NEW and EW07-NEW, were positioned in roughly a line extending from the southeast corner of the Erection Bay to extraction well EW02. The location of the proposed new wells and the PCE capture zones anticipated to develop after 10 years of pumping are shown in Figure 3-11. Maximum achievable pumping rates determined in the model were 9 to 11 gpm for wells EW05-NEW, EW06-NEW, and EW07-NEW, and 25 gpm for existing well EW02.

The estimated pore volume required to flush PCE contamination and the minimum time required to reach cleanup (i.e., the MCL for PCE) was calculated using the modeled extended extraction system. Table 3-2 provides these results. Due to the increased pumping rates and the distribution of new extraction wells, the estimated minimum time for required pore volume removal (approximately 17 pore volumes) prior to reaching the MCL was calculated to be approximately 25 years, or 64% less than required under existing conditions (EW01 and EW02 pumping at their current rates).

Finally, the calibrated model was used to place PCE particles at the perimeter of the contaminated zone (Zone C, concentrations > 5 μg/L) to evaluate capture under steady-state conditions. Figure 3-12 shows the results of this simulation. Capture of PCE from the far boundary of Zone C is achieved within 12 to 14 years, with complete capture of the more contaminated Zones A and B achieved in 1 to 5 years.

Finally, pneumatic fracturing technology was evaluated as a means to increase the hydraulic conductivity of the aquifer around each new extraction well, and thereby increase the yield of new wells. A sensitivity analysis was performed by simulating a zone of higher conductivity around each new extraction well in the model. The higher-conductivity zones had a maximum radius of approximately 25 feet, and post-fracture conductivity increases ranging from two times to 10 times greater than the surrounding formation (i.e., greater than 2 feet/day) were modeled. Results suggest that fracture-induced increases in hydraulic conductivity have the potential to increase overall well yields (from approximately 10 gpm to a maximum of 14 gpm from each new extraction well), and thereby further reduce the remediation time frame by approximately 3 to 7 years. The results of the evaluation are shown in Table 3-2 and Figure 3-13.

The effectiveness of fracturing will be dependent on the magnitude of conductivity increase achieved in the field. Model data suggests that the maximum reduction in remediation time frames occurs with a hydraulic conductivity increase of approximately 250% to 400% (i.e., an increase of three and one-half to five times). Additional factors that may affect fracture effectiveness include the achievable radius of influence and the ability to maintain open fractures over time. Although a reduction in the remediation time frame of 3 to 7 years is important, a cost benefit analysis was performed to determine whether the potential hydraulic conductivity enhancement will reduce the time frame for cleanup sufficiently, or provide other benefits, to justify the additional cost of fracturing.

Annual O&M costs for the existing treatment system at the Beloit site are approximately $100,000 per year. The estimated cost associated with performing pneumatic fracturing at three locations is $35,000. Based on the modeling performed, it has been estimated that fracturing will reduce remedial operations by 3 to 7 years. Assuming a conservative estimate of 3 years and an annual O&M cost of $100,000 per year, pneumatic fracturing will save approximately $265,000 in O&M costs (3 years * $100,000/year - $35,000). While pneumatic fracturing increases the cost associated with installing additional groundwater extraction wells, there is overall cost-savings associated with the project budget.

Based on this modeling, it is proposed that the design for the extraction system extension include three new extraction wells, rehabilitation of well EW02 to increase its pumping rate, and shutdown of EW01. Abandonment of EW01 is not recommended initially; however; this may be required after the extended extraction system becomes operational. To monitor the effectiveness of the extension system, six additional monitoring wells will be required within the Erection Bay area. Existing monitoring wells, including wells W23 and W23B, will continue to be used to monitor the new system, as will all other monitoring wells currently being sampled under the ISCA Quarterly Sampling efforts. Within a few years' time, it is anticipated that a measurable downward trend in VOC concentrations would be observed in Erection Bay monitoring wells, and a remediation end point could be estimated from the trend analysis. Performance of the new extraction system would also be subject to 5-year review, thereby providing an opportunity to make additional system adjustments or further enhancements to the overall remedy.

Table 3-1
Pre-ISCA Water Table Elevations
Beloit Corporation NPL Site, Rockton, Illinois

Well	8/25/92	9/21/92	11/12/92	3/9/93	5/26/93	8/12/93	1/24/94	6/3/94	6/22/94	8/26/94	10/28/94	12/30/94	2/24/95	4/14/95	6/23/95	11/9/95	11/15/95	5/2/96	Minimum	Maximum	Average
W6	725.11	726.06	726.04	726.72	728.02	727.64	725.83	725.46	725.28	724.77	725.25	725.74	725.34	725.98	725.74	726.12	726.42	727.08	**724.77**	**728.02**	**726.03**
W13	726.59	727.69	726.59	728.83	732.29	733.33	728.04	728.01	727.99	727.56	727.02	727.38	727.02	726.83	728.9	NM	728.5	728.18	**726.59**	**733.33**	**728.28**
W21	723.98	724.1	723.98	725.02	728.02	728.45	724.67	724.94	724.64	723.45	724.1	724.27	724.11	724.08	725.35	NM	724.67	NM	**723.45**	**728.45**	**724.86**
W23	727.38	727.99	727.44	728.04	731.34	732.02	728.04	728.27	727.93	727.66	727.54	728.11	727.32	727.47	728.97	728.72	728.9	728.01	**727.32**	**732.02**	**728.40**
W32	NM	NM	NM	NM	NM	NM	NM	NM	NM	727.8	727.69	728.03	727.64	727.27	729.34	NM	728.66	728.02	**727.27**	**729.34**	**728.06**
W34	NM	NM	NM	NM	NM	NM	NM	NM	NM	727.94	728.36	728.13	727.67	727.29	729.33	NM	729.13	727.36	**727.29**	**729.33**	**728.15**
W38	NM	NM	NM	NM	NM	NM	NM	NM	NM	723.19	723.83	723.94	723.74	723.95	724.84	724.31	724.49	724.75	**723.19**	**724.84**	**724.12**
W40	NM	NM	NM	NM	NM	NM	NM	NM	NM	728.03	728.14	728.36	727.95	727.57	729.48	NM	728.9	NM	**727.57**	**729.48**	**728.35**
W42	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	729.03	729.02	730.08	**729.02**	**730.08**	**729.38**
River Gage																					
SG6	NM	NM	NM	NM	NM	NM	NM	NM	NM	725.83	725.56	725.41	ICE	725.86	725.43	NM	726.57	726.15	**725.41**	**726.57**	**725.83**
SG7	NM	NM	NM	NM	NM	NM	NM	NM	NM	725.69	725.44	NM	ICE	725.51	725.42	NM	726.13	725.8	**725.42**	**726.13**	**725.67**
SG8	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	726.37	726.03	**726.03**	**726.37**	**726.20**
SG9	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	726.08	725.82	**725.82**	**726.08**	**725.95**

Key:
NM = Not measured.

Table 3-2
Estimated Pore Volumes Required to Flush PCE Plume
Erection Bay Source Area
Beloit Corporation NPL Site, Rockton, Illinois

Extraction System	Weighted Average Plume Concentration[1] (Cwo) (µg/L)	Radius of Circular Plume (feet)	Total Surface Area of Plume (A) (sq. ft.)	Top of Aquifer (amsl)	Bottom of Aquifer (amsl)	Thickness of Saturated Zone (B) (feet)	Porosity (n)	Pore Volume (PV)[2] (gallon)	Approximate Effective Withdrawal Rate[3] (gpm)	Time for One PV Removal (years)	Minimum Number of Pore Volumes Required to Reach MCL for PCE[4] (PVs)	Minimum Time to Reach MCL (years)
Existing ISCA	277	380	453,416	726	680	46	0.2	31,204,445	15.0	4.0	17.3	68.3
Extended Extraction System	277	380	453,416	726	680	46	0.2	31,204,445	41.5	1.4	17.3	24.7
Extended Extraction System with Pneumatic Fracturing[5]	277	380	453,416	726	680	46	0.2	31,204,445	54.5	1.1	17.3	18.8

Notes:

1. Weighted Average Concentration:

	Volume (gallons)	% of Total Vol.	Assumed Concentration
Zone A (>1,000 µg/L)	2,160,973	6.93%	1500
Zone B (100 - 1,000 µg/L)	8,778,951	28.13%	500
Zone C (5 - 100 µg/L)	20,264,521	64.94%	50
Total Plume (>5 µg/L)	31,204,445	100.00%	
		Weighted Ave. =	277

2. Pore Volume (EPA/540/S-97/504):
   PV = BnA
   where:
   B = Thickness of plume (equal to saturated thickness)
   n = Porosity
   A = Area of the plume (total surface area for Zones A, B, and C)

3. Existing ISCA: Assumes half the water withdrawn by EW01 (approx. 5 gpm) comes from contaminated Zone A. Remainder (5 gpm) comes from upgradient and is not included.
   Also assumes half the water withdrawn by EW02 (approx. 10 gpm) comes from contaminated Zone C. Remainder (10 gpm) comes from downgradient (< 5 ug/L) and is not included
   Extended Extraction System: Assumes 11 gpm from EW05-NEW, 9 gpm from EW06-NEW and EW07-NEW, and 12.5 gpm (i.e., half of 25 gpm total withdrawal) from EW02 after rehabilitation.
   Extended Extraction System w. Fracturing: Assumes 14 gpm from EW05-NEW, 14 gpm from EW06-NEW and EW07-NEW, and 12.5 gpm (i.e., half of 25 gpm total withdrawal) from EW02 after rehabilitation.

4. Number of Pore Volumes required to reach cleanup (EPA/540/S-97/504):
   No. of PVs = -R ln (Cwt / Cwo)
   where:
   Contaminant = PCE
   Retardation Factor (R) = 4.3 http://www.epa.gov/Athens/learn2model/part-two/onsite/retard.htm
   Cleanup concentration (Cwt), i.e., MCL = 5 µg/L
   Initial Aqueous Concentration (Cwo) = See table above.

5. Assumes fracture-induced hydraulic conductivity increase to 10 feet/day (i.e., a 400% increase, or 5 times greater than exisitng formation conductivity [2 feet/day])

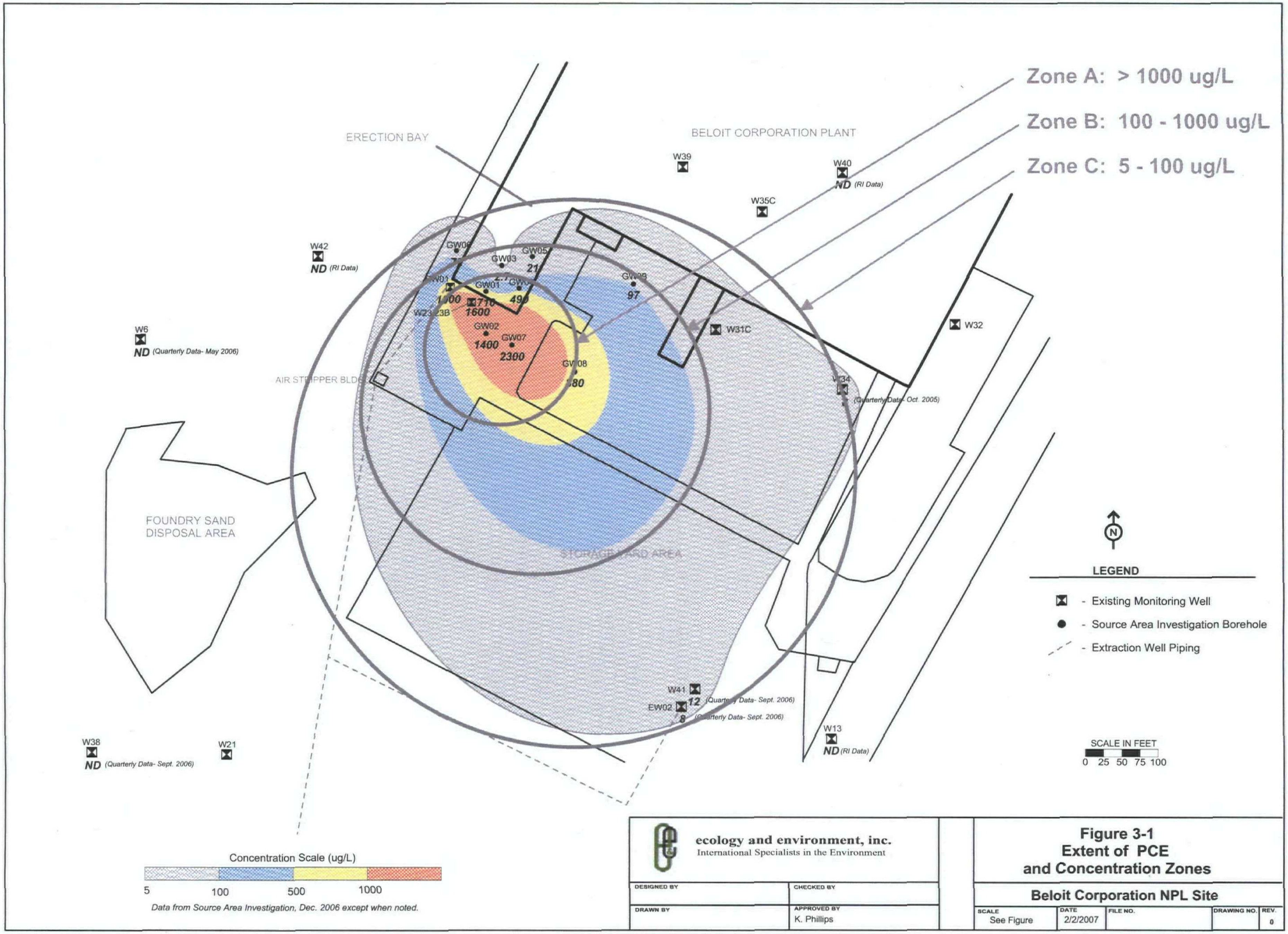
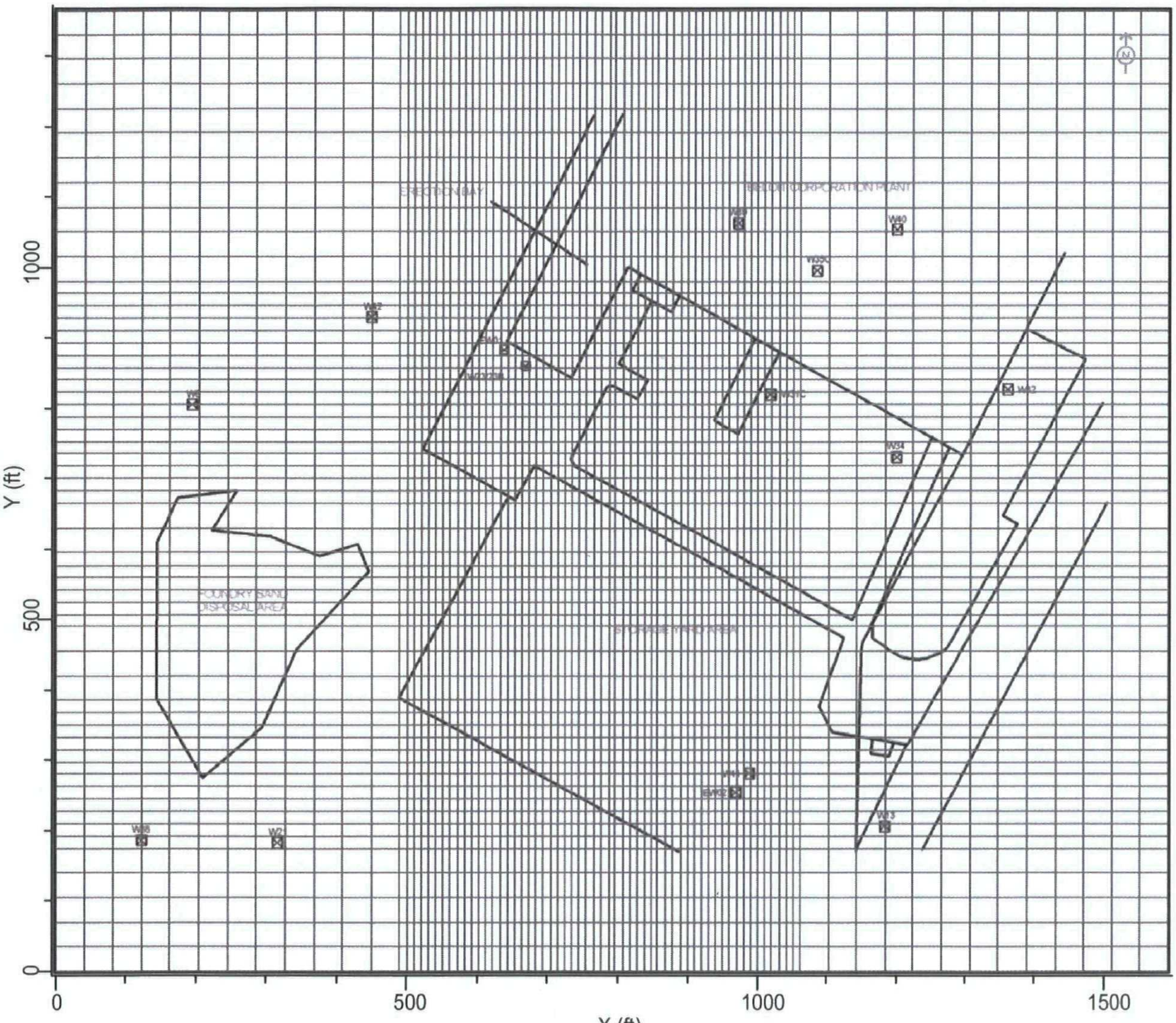


Figure 3-1
Extent of PCE and Concentration Zones

Beloit Corporation NPL Site



Source: WHI FLOWPATH II v 1.1

No. Columns: 83 No. Rows: 58

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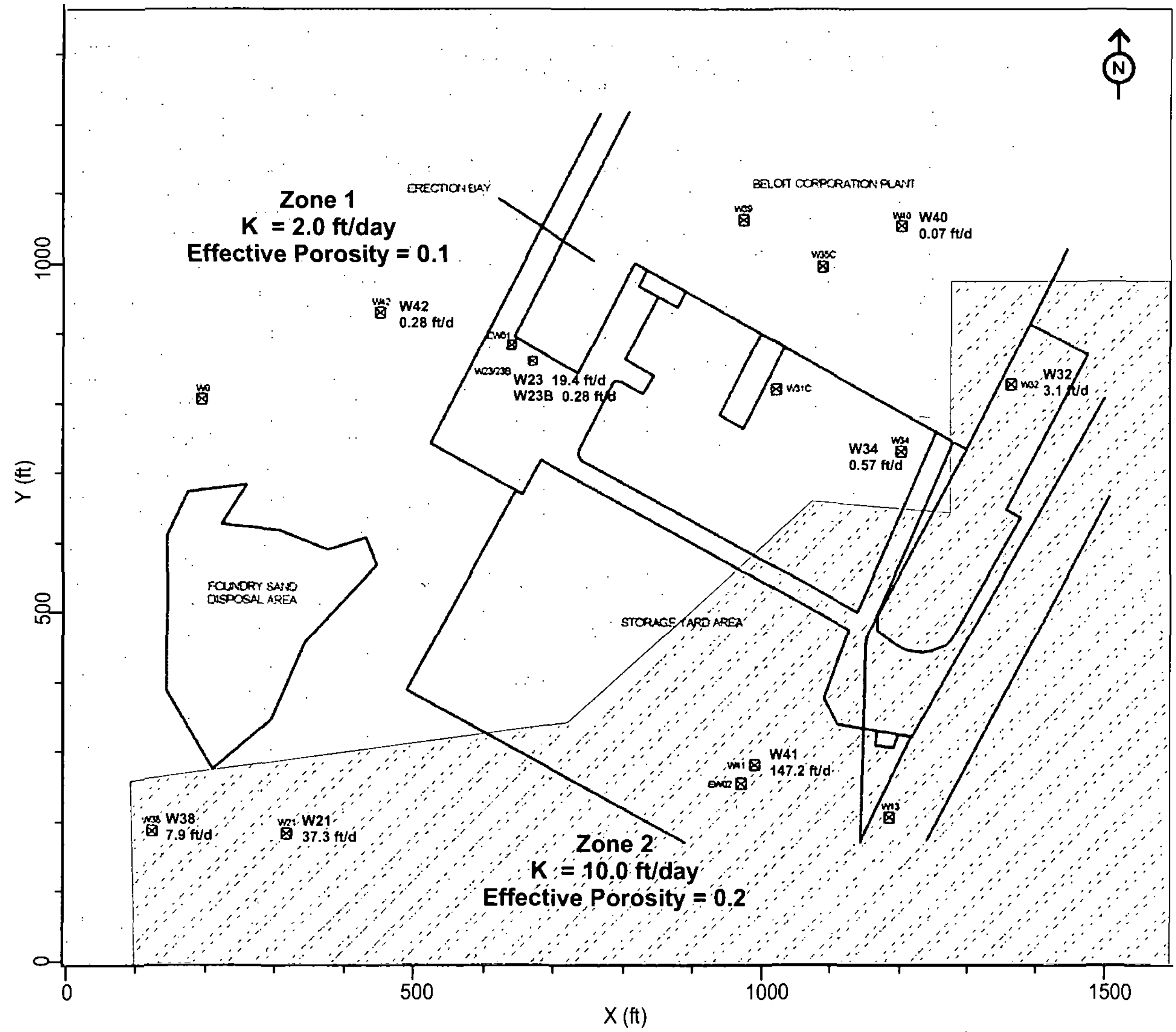
Figure 3-2
Model Grid

Beloit Corp. NPL Site, Rockton, Illinois

SCALE	DATE	FILE NO.	DRAWING NO.	REV.



Source: WHI FLOWPATH II v 1.1

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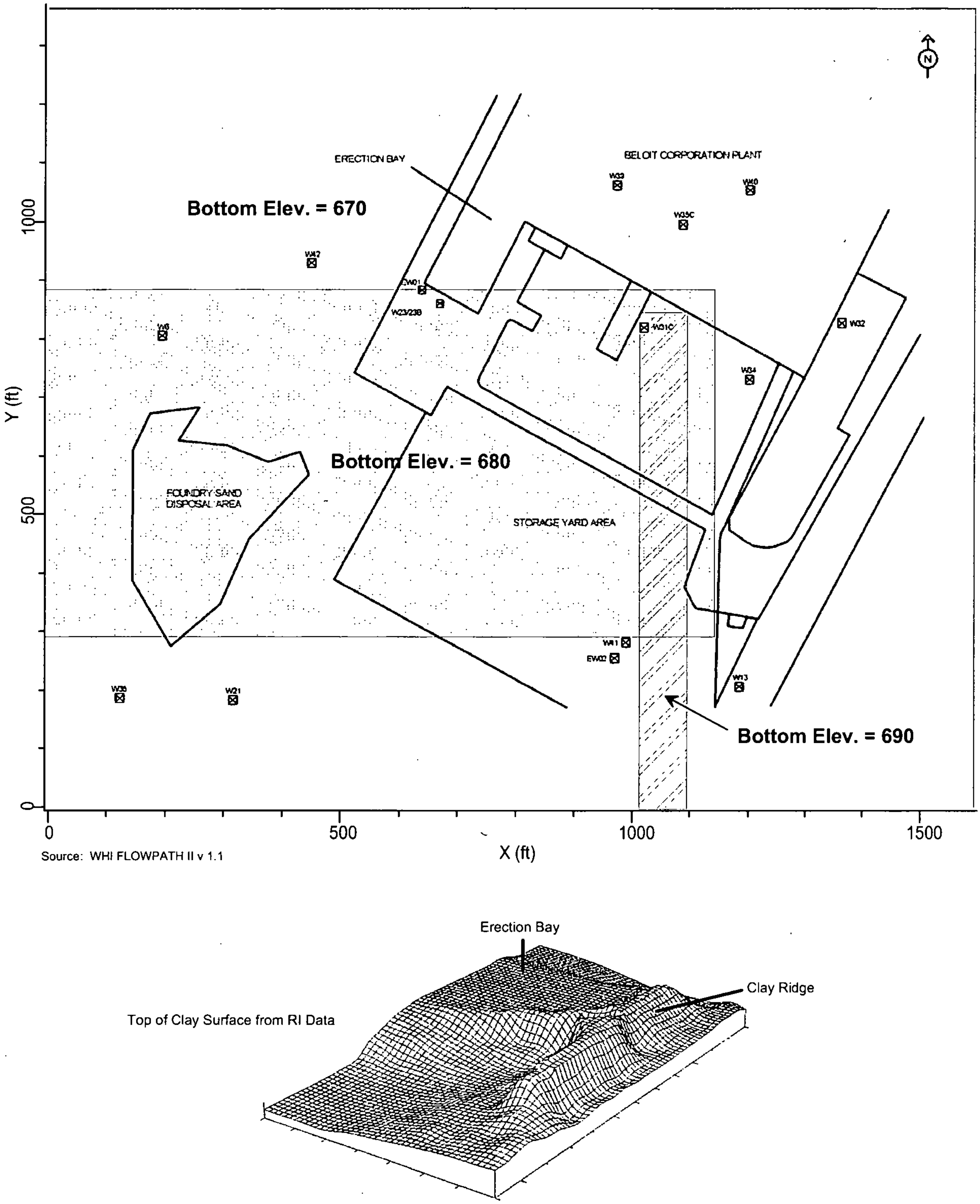
Figure 3-3
Model Conductivity and Porosity Zones

Beloit Corp. NPL Site, Rockton, Illinois

SCALE	DATE	FILE NO	DRAWING NO	REV



Source: WHI FLOWPATH II v 1.1

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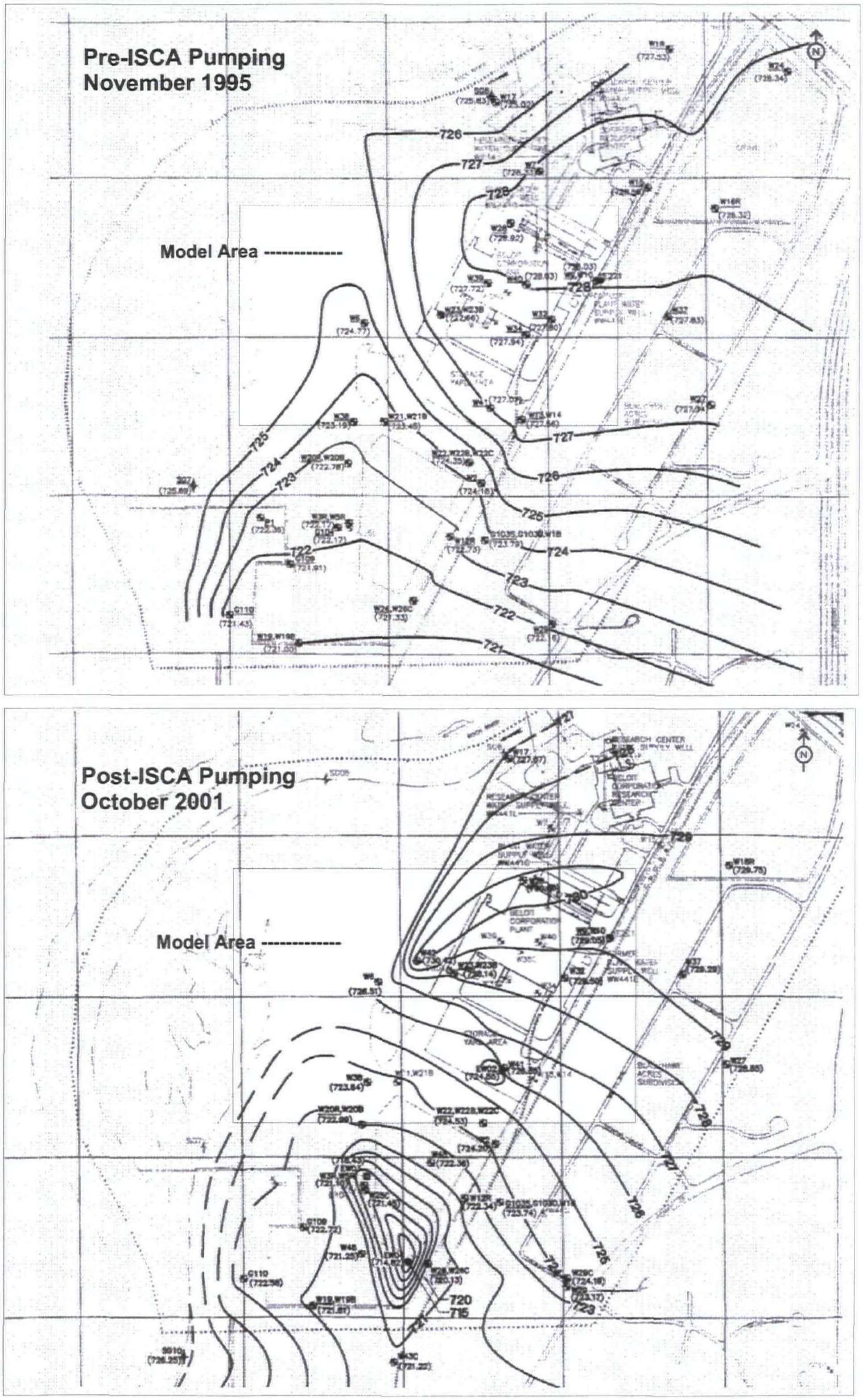
Figure 3-4
Model Aquifer Bottom Elevations

Beloit Corp. NPL Site, Rockton, Illinois

SCALE	DATE	FILE NO	DRAWING NO	REV



Map Sources:
November 1995 Map - RI/FS Technical Memorandum 3, Sept. 1996, Montgomery Watson.

October 2001 Map - Quarterly ISCA Report, August -October 2001, dated January 2002, Montgomery Watson Harza.

Scale: See original reports.

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Figure 3-5
Typical Water Table Contours Pre- and Post ISCA

Beloit Corp. NPL Site, Rockton, Illinois

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	8/14/07			1

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Figure 3-6
Model Boundary Conditions

Beloit Corp. NPL Site, Rockton, Illinois

SCALE | DATE | FILE NO. | DRAWING NO. | REV.

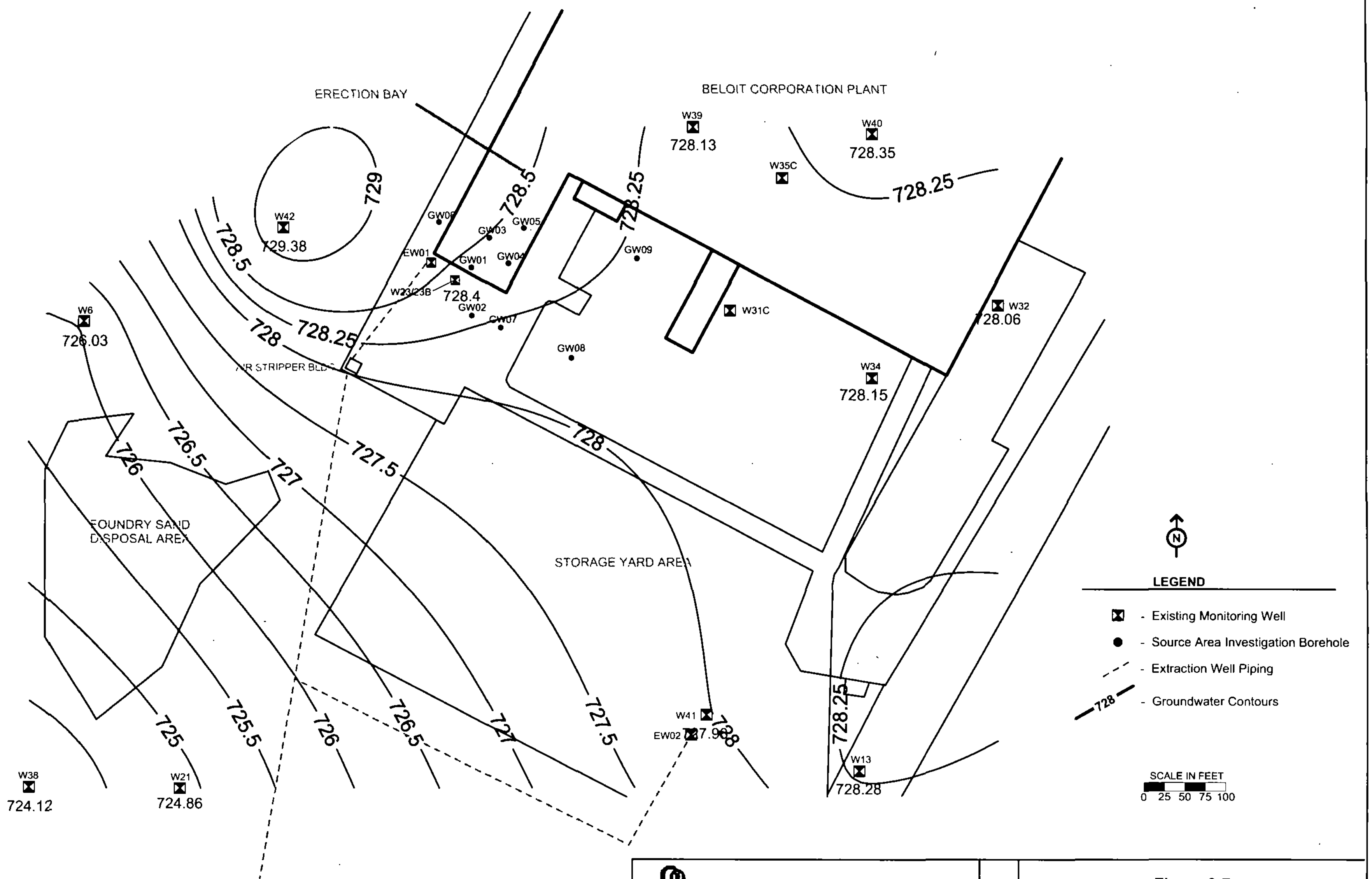

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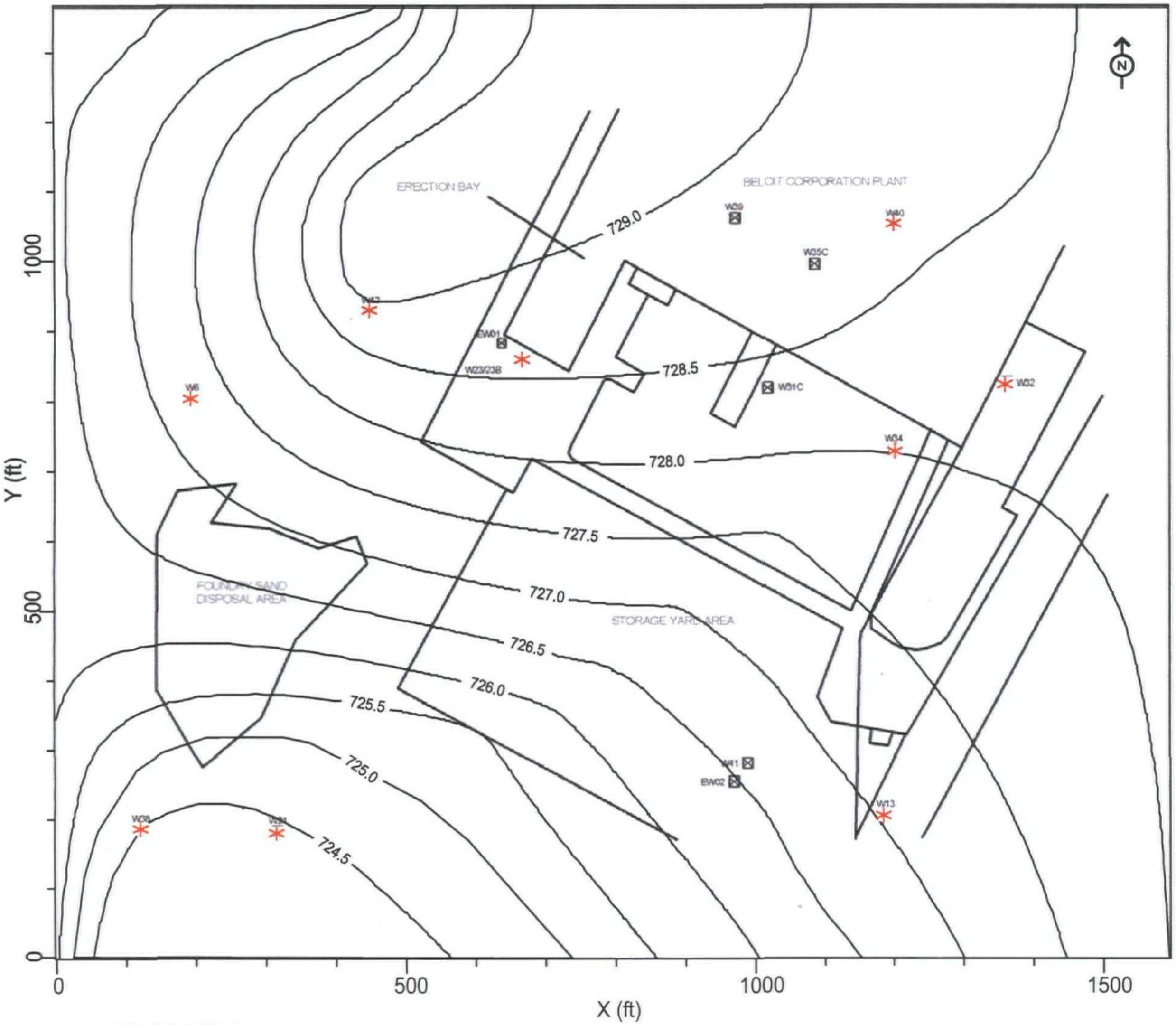
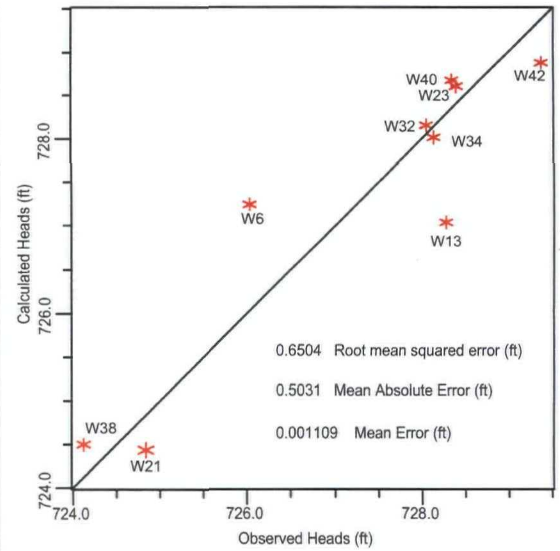
Figure 3-7
Pre-ISCA Average Water Table Map

Beloit Corporation NPL Site

SCALE	DATE	FILE NO	DRAWING NO.	REV
See Figure	8/4/2007			1



Source: WHI FLOWPATH II v 1.1



Flow Model for DataSet =
C:\Program Files\WHI\Beloit\ERECTION BAY_ NO PUMPING
Calculating hydraulic heads. Solver : PCG, unconfined aquifers.
Outer Iteration #1
Maximum head correction : 0.0000 (0.0000 ft)
occurred at node H[0,0] = 0.0000
Outer Iteration #2
Maximum head correction : 0.0086 (0.0560 ft)
occurred at node H[16,22] = 726.7695
Outer Iteration #3
Maximum head correction : 0.0001 (0.0009 ft)
occurred at node H[19,24] = 727.0360
Global water balance [ft^3/d] :
1286.7312 IN const. head nodes
-3019.3978 OUT const. head nodes
0.0000 IN flux nodes
0.0000 OUT flux nodes
636.1841 IN river nodes
-815.1035 OUT river nodes
0.0000 IN Drain nodes
0.0000 OUT Drain nodes
0.0000 IN injection wells
0.0000 OUT pumping wells
1911.5221 net aquifer recharge
0.0000 IN leakage from below
0.0000 OUT leakage from below
0.0000 IN leakage from above
0.0000 OUT leakage from above
-0.001670% total mass balance error

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Figure 3-8
Calibrated Groundwater Flow Map

Beloit Corporation NPL Site

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	8/4/2007			1

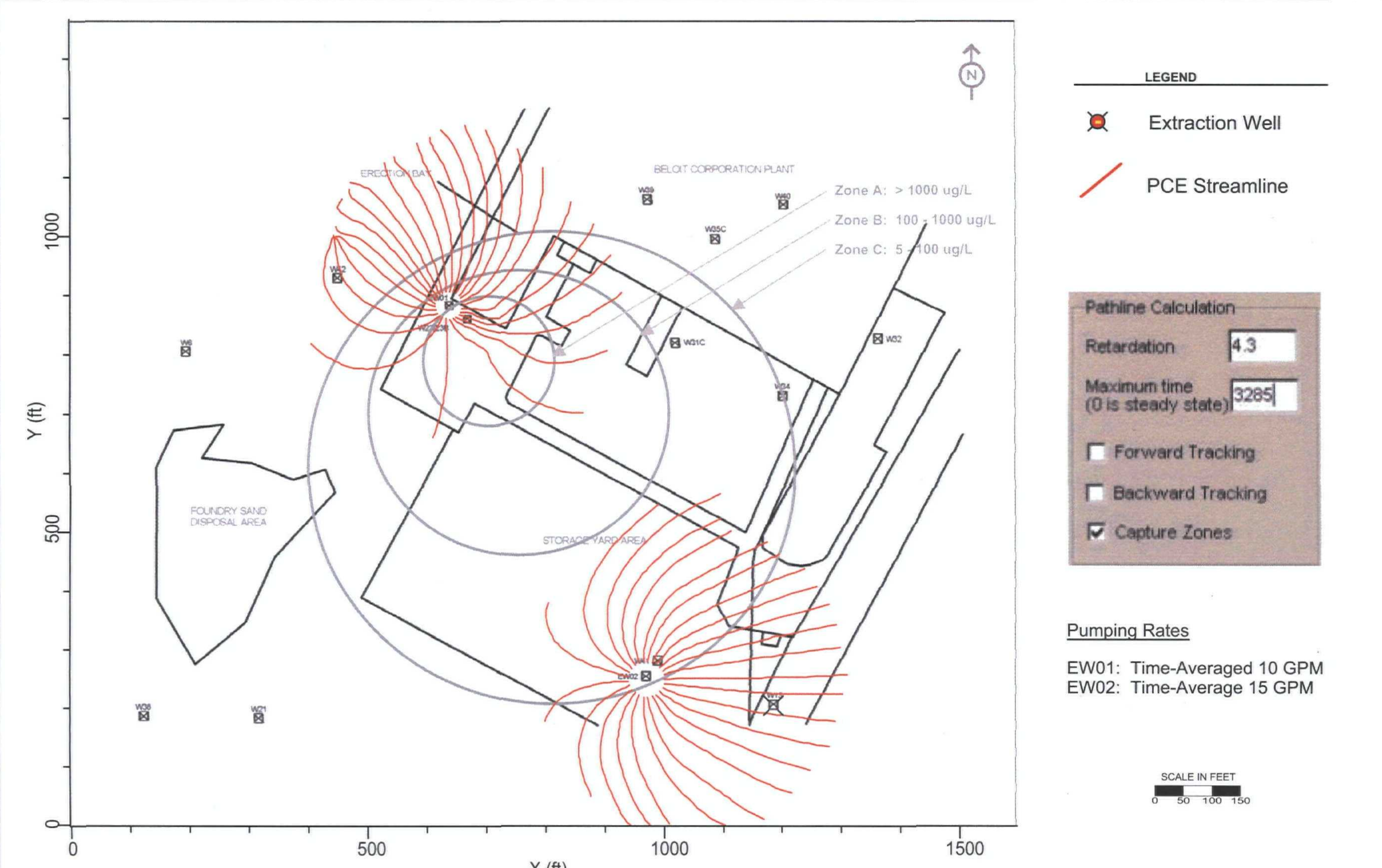

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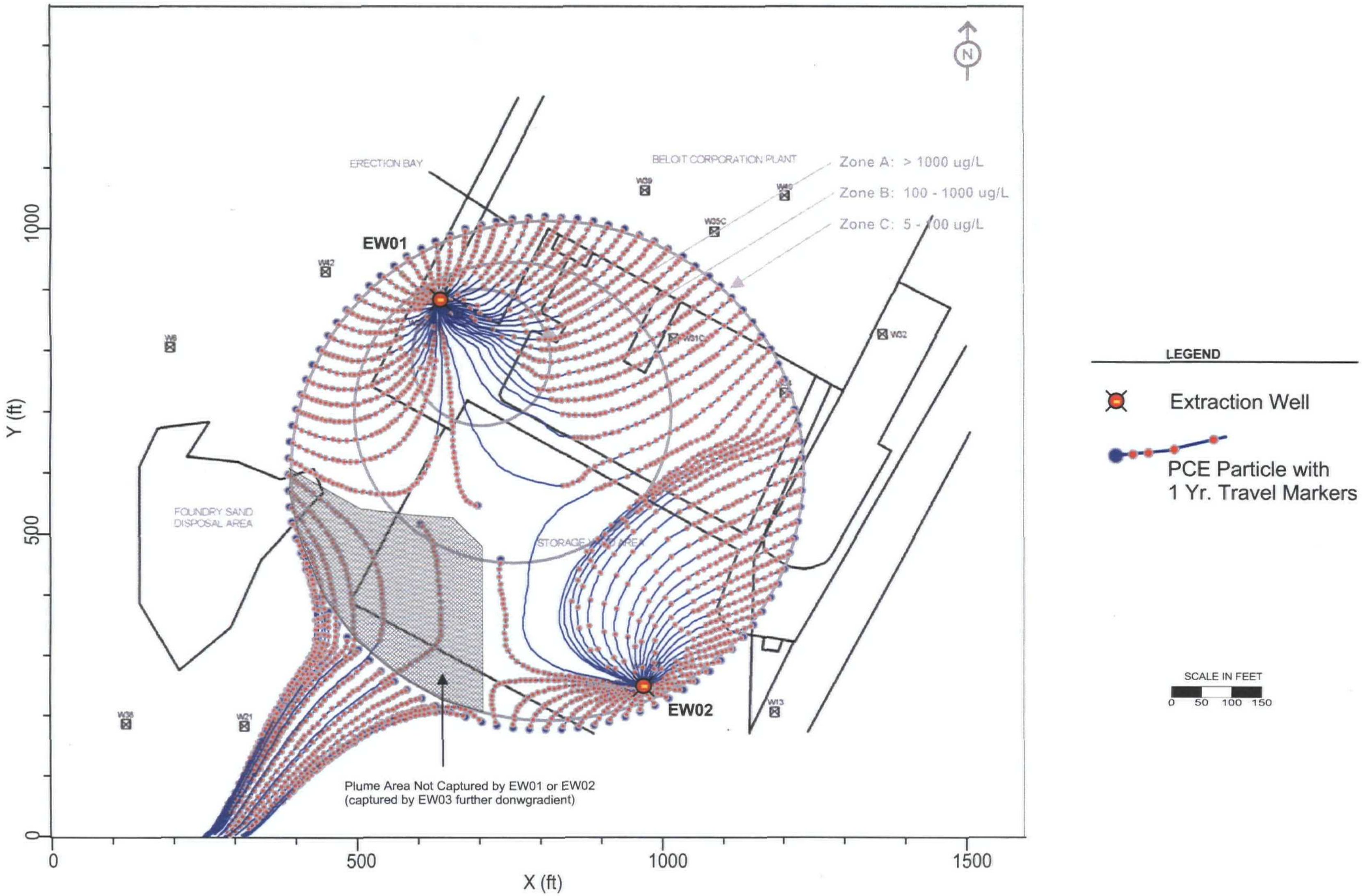
Figure 3-9
9 Yr. PCE Capture Zone, ISCA Wells EW01 and EW02

Beloit Corp. NPL Site, Rockton, Illinois

DESIGNED BY	CHECKED BY	SCALE	DATE	FILE NO.	DRAWING NO.	REV.
DRAWN BY	APPROVED BY					

Source: WHI FLOWPATH II v 1.1



Source: WHI FLOWPATH II v 1.1

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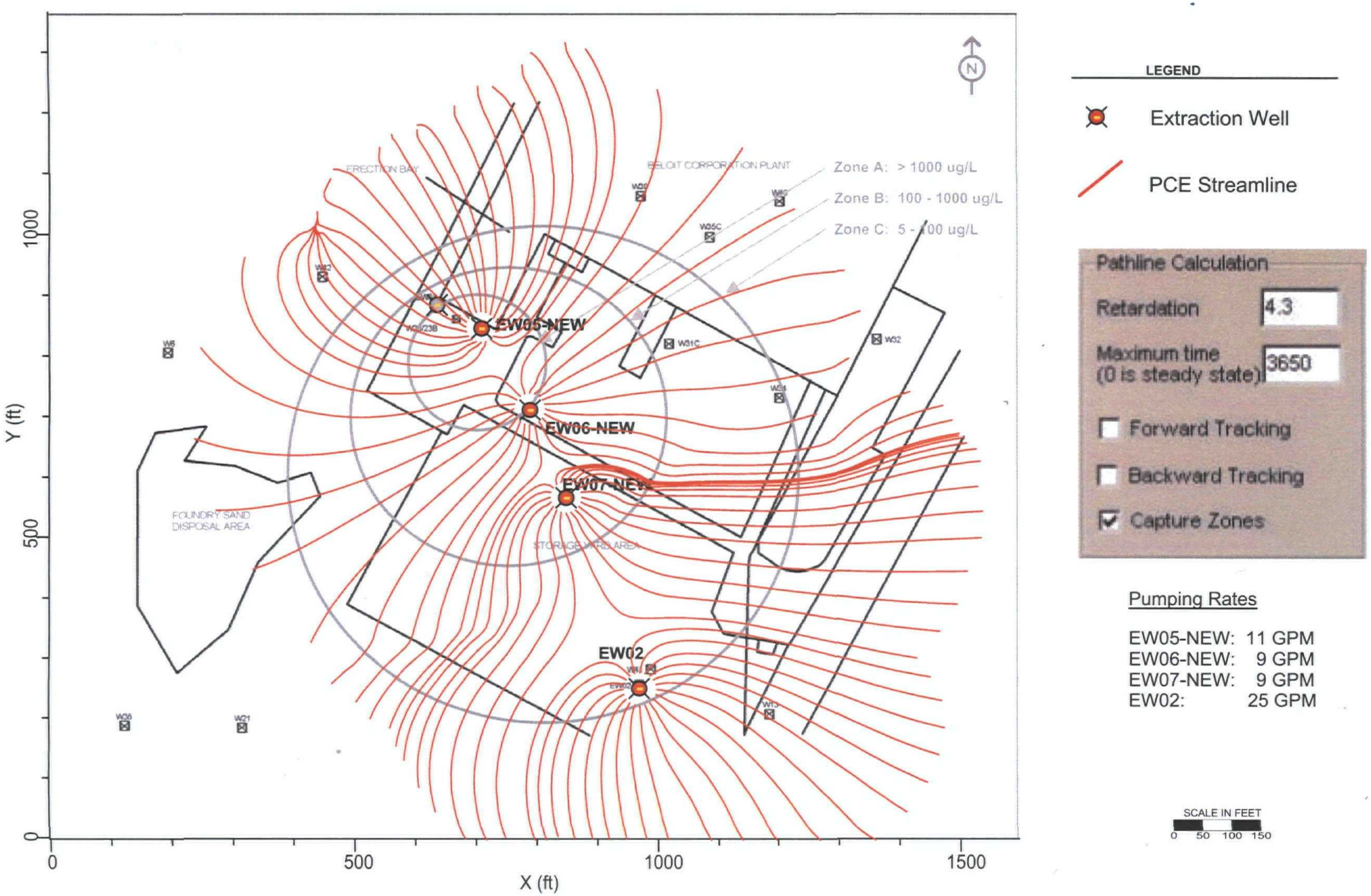
Figure 3-10
PCE Particle Capture Map, Existing ISCA System

Beloit Corp. NPL Site, Rockton, Illinois

SCALE	DATE	FILE NO.	DRAWING NO.	REV.



Source: WHI FLOWPATH II v 1.1

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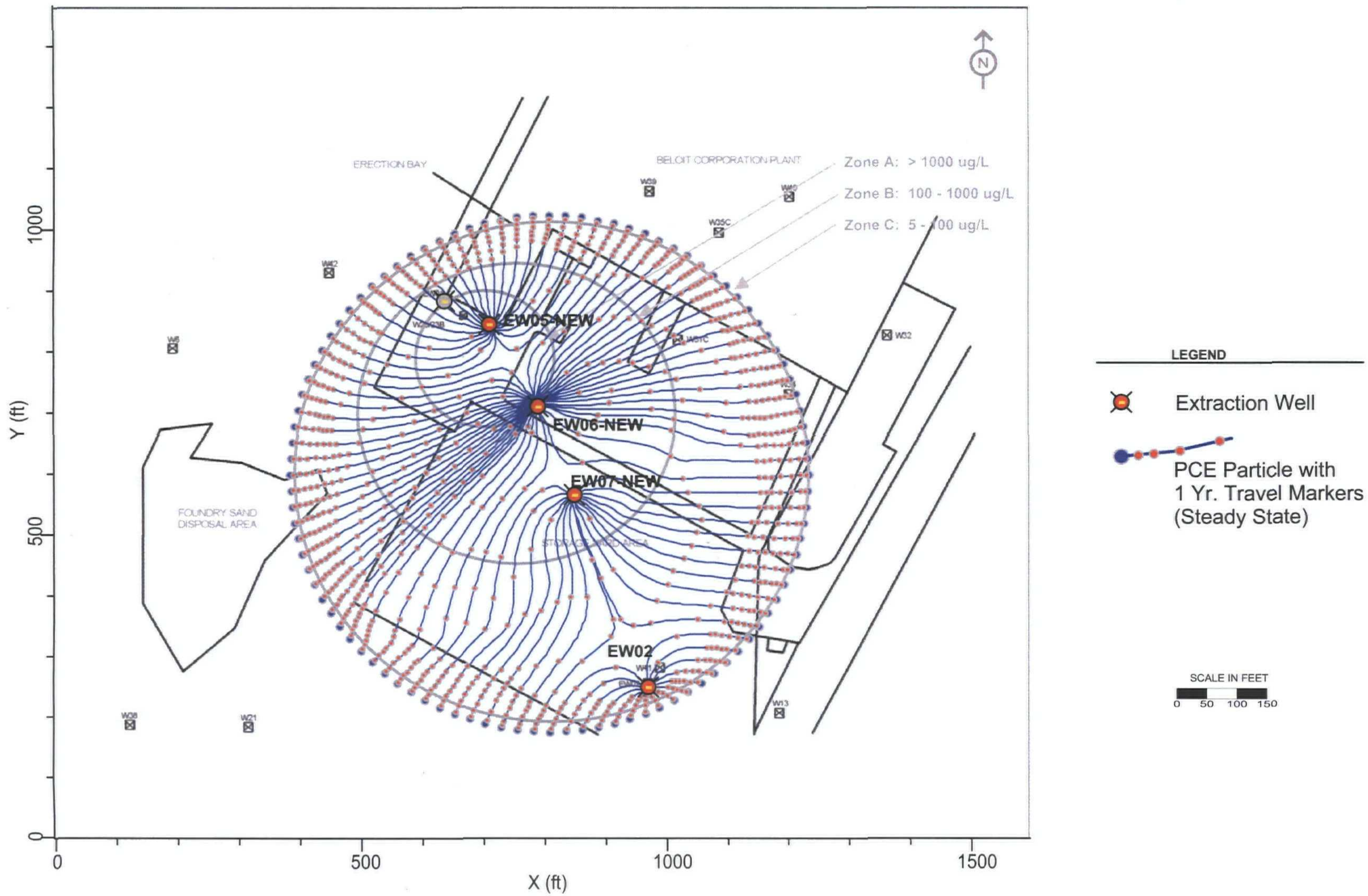
Figure 3-11
10 Yr. PCE Capture Zones,
Extended Extraction System

Beloit Corp. NPL Site, Rockton, Illinois

SCALE	DATE	FILE NO.	DRAWING NO.	REV.
	0813/07			1



Source: WHI FLOWPATH II v 1.1

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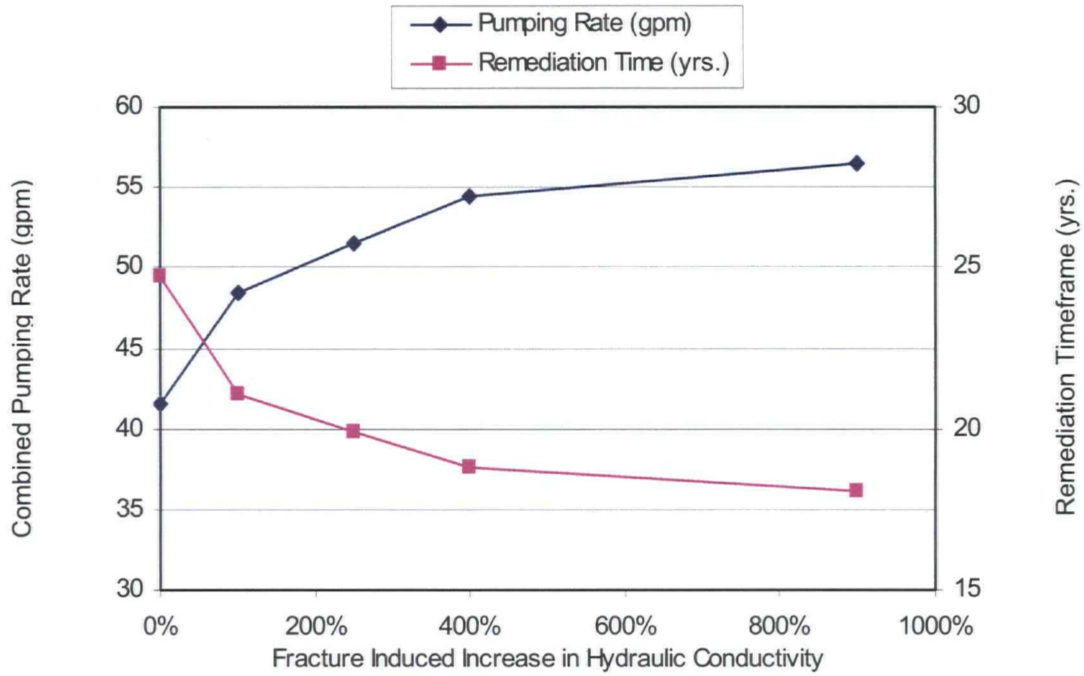
Figure 3-12
PCE Particle Capture Map, Extended Extraction System

Beloit Corp. NPL Site, Rockton, Illinois

SCALE	DATE	FILE NO.	DRAWING NO.	REV.



K (ft/d)	% Increase in K	Pumping Rate (gpm)	Remediation Time (yrs.)
2	0	41.5	24.7
4	100%	48.5	21.1
7	250%	51.5	19.9
10	400%	54.5	18.8
20	900%	56.5	18.1

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DRAWN BY	APPROVED BY K. Phillips

Figure 3-13
Fracture Induced Increase in Hydraulic Conductivity

Beloit Corporation NPL Site

SCALE	DATE	FILE NO.	DRAWING NO.	REV.
	8/13/2007			0

4 ISCA Engineering Evaluation

On March 26 and 27, 2007, EEEI performed an ISCA Engineering Evaluation concurrently with the quarterly groundwater sampling event conducted by Illinois EPA's Corrective Action Contractor (CAC) and O&M Contractor, BES. During the ISCA Engineering Evaluation (ISCA EE), the system components were inventoried and layouts of equipment, electrical, and control systems were evaluated.

As stated in Section 2 of this report, the RD WP included performing a pilot test to determine dosage of in situ chemical oxidation injections. However, because chemical oxidation was determined to be impractical, installation of three extraction wells within the source area is being implemented with well placement as described in Section 3. Therefore, the ISCA EE was also used to determine how extraction well force main and electrical connections to the existing pump-and-treat system would be accomplished.

4.1 ISCA Engineering Evaluation Findings

The RD WP stated that at a minimum EEEI would perform the following tasks as part of the ISCA EE:

1. Evaluate the main electrical feed from the former Beloit Corporation Plant to the treatment building to determine whether proper voltage and/or amperage is present;
2. Evaluate the Blancett flow meters located in the influent lines;
3. Evaluate the level control for the air stripper sump section;
4. Reevaluate the discharge pump to determine whether it is still drawing excess amperage on one leg of its three-phase service;
5. Correct the safety issue of the open leak detection sump;
6. Evaluate access to the treatment building telemetry system;
7. Address problems with the effluent line; and
8. Evaluate the condition of all monitoring wells.

The main electrical feed from the former Beloit Corporation Plant to the treatment building was repaired by a licensed electrician between the time that the RD WP was prepared, and the ISCA EE was performed. BES oversaw the repair of the electrical feed. EEEI removed the cover of the main feed electrical panel to check whether proper voltage was present. EEEI found 490 to 495 volts alternating current (VAC) across the three legs of the three-phase system. Based on this finding, the incoming feed has less than a 1% voltage unbalance and less than 10% overvoltage of the stated transfer pump motor nameplate voltage, all within acceptable ranges for proper motor operation. Because the system was shut down during testing due to problems with effluent line flow, blower voltage and amperage to the motor could not be tested. Additionally, the transfer pump motor could not be checked to determine whether it was still drawing excess amperage on one leg of its three-phase service because it had stopped working. Following the ISCA EE, a new motor was ordered and installed upon delivery. BES oversaw the installation of the new motor. However, while BES was planning to have the feed to the transfer pump checked again, it appears that all electrical feed problems to the pump-and-treat system had been resolved.

When the RD WP was written, it was thought that Blancett flow meters were located on the influent lines. Upon visiting the site, however, EEEI found that the lone Blancett flow meter is located on the effluent line. The influent lines contain direct-read flow totalizers only. The O&M technician records the total gallons pumped to date and estimates a flow rate from each extraction well using the totalizer readings. The Blancett flow meter on the effluent line has a digital readout displaying the current flow rate and amount of effluent to date. The weekly flow meter reading does not match the sum of totals as displayed by the influent line totalizers, so it is not used by the O&M technician. Total effluent is reported as the sum of all influent line totalizers.

The level control for the air stripper sump section has been repaired since the writing of the RD WP and is now operating correctly. The high level and high-high level floats had apparently been sticking and allowing water to contact the electronics.

During the ISCA EE, the open leak detection sump was measured so that final plans and specifications can specify a sump cover. The sump is 11.25 inches in diameter. The level control within the sump is not operational, and an open electric conduit box for the control circuitry exists. A check of the telemetry system was made. The telemetry system operates over a phone line and could be operational if phone service was obtained for the building. An existing phone line was traced exiting from the pump-and-treat building; however, based on the setup of the pump-and-treat system, EEEI does not feel that an autodialer is necessary. The autodialer is the only way that currently exists to obtain motor run times for the system.

The condition of all monitoring wells was recorded by EEEI during the SAI. The findings of the SAI monitoring well evaluation were compared to notes obtained from BES following quarterly water level readings and groundwater sampling for the first quarter of 2007 to produce Table 4-1. The findings of the SAI matched BES's results, except for well W2, which has been damaged since the SAI. W2 was damaged when a steel beam staged next to this well, by Reload, Inc. fell against it. A complete listing of all wells was presented in the SAI Technical Memorandum (E & E 2007). The final design will include plans and specifications for abandonment and/or repair of those monitoring wells listed as damaged.

Problems with the effluent line are being addressed separately from this design. Effluent line modification plans and a statement of work prepared by EEEI are being implemented by BES as part of the ongoing system O&M. Effluent line modifications entail installing manholes at key locations so that the effluent line can be repaired and cleaned as necessary to correct flow and allow future maintenance.

Sections 4.2 and 4.3 present additional information gathered about the current arrangement of the ISCA pump-and-treat system. The information was collected during the ISCA EE and from the current Beloit Corporation O&M Manual.

4.2 Existing Groundwater Treatment System

The existing ISCA pump-and-treat system consists of four extraction wells (EW01, EW02, EW03, EW04), which pump contaminated groundwater to the on-site treatment building. EW04 has two groundwater extraction pumps installed, which are designated as EW04 pump 1 (EW04-1) and EW04 pump 2 (EW04-2). The treatment building contains an air stripper that removes VOCs from contaminated groundwater. Treated groundwater is then discharged to the former Beloit Corporation Research and Development manhole via an underground piping run, with the effluent ultimately discharging to the Rock River.

The air stripper consists of a packed, forced draft air stripping column designed for VOC removal. Contaminated groundwater enters near the top of the column, flows downward across the packing, and is collected in a sump at the column base. The packing consists of polypropylene ellipsoids that are violently lifted by the forced draft air. Air is introduced to the system near the column base by a belt-driven blower. The blower is fed by outside air and vented through the top of the column. A demister prevents water from leaving the top of the column. Treated water is discharged in batches via a 450-gallon per minute transfer pump.

The air stripper is a Turbostripper model manufactured by Diversified Remediation Controls Incorporated. Based on Discharge Monitoring Reports (DMRs) recently submitted to the Illinois EPA Compliance Assurance Section by the

O&M contractor, BES, the system is effectively treating extracted groundwater at current flow rate, air volume, and influent concentrations.

The ISCA pump-and-treat system is powered from an underground electrical feed from the former Beloit Corporation building, now managed and run by Reload, Inc. The feed consists of three-phase, 480 VAC, which enters through the floor of treatment building into electrical busway. The busway contains all electric wiring between the 480-volt (V) panel, 240V panel, and control panel. The 480V panel has circuit breakers for all five well pumps, the 25-kilovolt-ampere (kVA) transformer, transfer pump, air stripper blower, and building heater. The three additional wells being added to the system will also have wiring running through this panel. The 480V panel has 16 remaining twistout slots open; each well will require three twistout slots grouped together in order to be installed, which, based on the spacing in the panel, allows up to four additional wells to be installed. Therefore, an additional subpanel located off the 480V panel will not be required.

The 480V panel feeds the 25-kVA transformer that in turn feeds the 120V panel. The 120V panel has circuit breakers for the building exhaust fan, lights, receptacles, and control panel blower. There are several open twistouts, although none will be required for this design. The third panel contains all of the controls for system operation. The control panel has hand/off/auto (HOA) switches for the five well pumps, air stripper blower motor, transfer pump motor, and drain solenoid. Additional HOA switches will be required for each well pump added to the system, and these additions will be incorporated into the 95% Design Documents.

The system is controlled by an Allen-Bradley Modicon programmable logic controller (PLC). The PLC runs a program using the ProWorks NXT Lite software. A printout of the program was obtained during the ISCA EE. The program will require an upgrade to add the additional wells and associated control components to the system. The PLC has three input and output (I/O) modules consisting of two 24-volt direct current (VDC) input modules with 16 terminals per module and one 115-VAC output module with 16 terminals. There are seven spare input terminals. Each new well will require two input terminals, one for relaying that the HOA switch is in the Auto position requiring PLC control and one from the well pump giving its running status. Three wells will require six of the seven available inputs; therefore, the input module has the capacity for the intended system upgrades. The output module has eight spare terminals. Each well only requires one output terminal to relay stop and start commands, so adequate space is available. I/O modules will not need to be added, or upgraded to 32 terminal modules, to introduce three new extraction wells to the system.

The control panel contains the electric feed terminal blocks and motor starters for each of the five existing well pumps. There is no spare terminal block available for wiring hookups and only room for one additional motor starter within the control panel. Hookup of three additional extraction wells to the control panel will require a subpanel mounted adjacent to the existing control panel and connected with conduit/bus runs. Sixteen inches of space is present to the right of the panel for subpanel mounting.

After system evaluation, it has been determined that design of the system will require detailed electrical design calculations and drawings. EEEI will subcontract an Illinois-licensed professional electrical engineer to complete this portion of the design.

During the ISCA EE, EEEI reviewed Operations Logs that had been completed by the O&M contractor. These logs date back to the startup of the plant. Initial flow rate records from EW02 show the well producing at 30 to 35 gpm. This rate is followed by an abrupt change in which EW02 begins to produce flow at a reduced rate of 12 to 14 gpm, the rate at which it remains to this day. Although the flow rates of wells EW01, EW02, and EW03 have decreased from initial flow rates, EW02 has had the most noticeable decline in production. At the time this occurred, attempts were made to restore the original production rates from this well; however, EW02 has never produced at the rates originally seen.

Following the ISCA EE, EEEI performed initial pipe sizing calculations for the three new extraction well pumps. Since all of the force mains come together within a single manifold pipe, it was required to model all of the existing pumps together. When a single manifold exists, it is necessary for the pressure within all pipes to be nearly the same or else one pump will "step on" another. This means that one well can prevent another well from pumping because the pressure differential at the connections/interface is too great, and the well with the greatest pressure continues to pump. With moderate pressure differences, one well can restrict flow from another well without completely shutting down flow. It can be hypothesized that the fall in production for all wells is due to the effects following the addition of pump 2 in EW04. However, EEEI does not currently have information available showing the exact date that EW04-2 started pumping to the system.

I don't have

4.3 Existing Groundwater Extraction Wells

Four extraction wells are currently in operation. Construction details for extraction wells EW01 through EW04 are presented in the current O&M Manual. The wells are constructed with carbon steel riser sections and #304 stainless steel continuous wire wound screens. The wells were completed above grade, but protective casings were not installed. Concrete bollards protect the well risers. Additional construction details are presented in Table 4-2.

The building foundation was boxed out to allow access for piping runs. The original design drawings indicate that the EW01 force main and electric line, and the main three-phase, 480V electrical feed run from the southwest corner of the Erection Bay to the northwest corner of the P&T building. The remaining extraction well force mains and electric lines run from the wells to the south end of the P&T building. All force mains extend through the floor on the south end of the building, and all electric lines surface through the floor on the east side of the building. The electric lines were installed via direct burial except for the final 10 feet prior to entering the P&T building. The high-density polyethylene (HDPE) force mains extend through polyvinyl chloride (PVC) floor collars and connect to galvanized metal piping. All force mains are 2 inches in diameter with EW01 and EW02 reducing to a 1 inch diameter within the P&T building before the manifold piping, and EW03, EW04-1, and EW04-2 remaining 2 inches in diameter up to the manifold pipe.

There are two spare piping runs extending through the treatment building floor, and both are 2 inches in diameter. Additionally, two spare electrical conduit runs also enter the building. The existing force mains, except for EW04-2, have a pressure switch installed, followed by a direct-read pressure gauge, and flow control valve. The 1-inch lines have a Badger Recordall Model 70 totalizer, and the 2-inch lines have Badger Recordall Model 120 totalizer, except for EW04-2 which has a Hershey MVR160 totalizer. Each line has a 0.75-inch boiler drain (spigot) for sample collection, a second flow control valve, and a brass check valve before entering a 6-inch Schedule 80 PVC manifold pipe.

4.4 System Modeling

Operating and manufacturer's data from the ISCA pump-and-treat system was gathered to determine current operating conditions of the system. Based on the current operating conditions, extrapolations of the findings were made to determine whether the system could still function with the increased flow and influent concentrations from the three proposed well locations. The following sections discuss the findings of these investigations in detail.

4.5 Physical Component Capacities

From manufacturer literature, the Turbostripper has the capacity to treat 400 gpm of extracted groundwater based on the physical design of the column and blower sizing. The transfer pump has the capacity to discharge 450 gpm of treated groundwater, also based on manufacturer literature.

The effluent pipe is constructed of approximately 1,900 feet of Schedule 40 PVC pipe. The change in elevation from the ISCA pump-and-treat building to the Rock River is approximately 25 feet. This elevation change assumes a pump elevation of 755 feet amsl and a surface water elevation on the Rock River of 730 feet amsl. Assuming gravity flow from the treatment building with only pipe friction losses, i.e., no losses due to pipe bends, the effluent pipe is capable of draining at a flow rate of 380 gpm with a velocity of 4.27 feet/second. See the gravity flow calculations in Appendix B.

Calculations were also performed to determine the size of transfer pump needed to discharge water through the piping at an assumed discharge flow rate of 10% over the stripper column capacity (440 gpm) and with nine 90-degree elbows and eight 45-degree elbows. Based on the calculations with a safety factor of 2, the design head of the pump must be greater than 107 feet and have a design horsepower (hp) of equal to or greater than 14. The transfer pump installed at the plant is a 15-hp Goulds pump capable of discharging 450 gpm. At a maximum pump flow rate of 450 gpm and a safety factor of 1.25, the pump would exert a pressure of 90 pounds per square inch (psi) on the effluent piping. Six-inch Schedule 40 PVC pipe is rated for a working pressure of 180 psi in compliance with both American Society for Testing and Materials (ASTM) D1785 (pressure pipe) and ASTM D2665 (drain, waste, and vent pipe). See Appendix B for pressurized pipe calculations.

4.6 NPDES Permit

Treated groundwater is discharged to the Rock River under a NPDES permit through an outfall located on the former Beloit Corporation property. NPDES permit number IL0064564 was issued for the P&T System on March 25, 2005 and will expire on April 30, 2010. The treatment plant must operate in a manner that meets the requirements of the NPDES permit as reported on the DMRs. The permit establishes discharge load limits in pounds per day and concentration limits in milligrams per liter (mg/L) for the following VOCs: 1,2-dichloroethane (1,2-DCA), 1,1,1-TCA, TCE, PCE, 1,2-dichloroethylene (1,2-DCE), 1,1-dichloroethane (1,1-DCA), and 1,1-dichloroethylene (1,1-DCE). Table 4-3 presents the requirements of the NPDES permit.

The system capacity is based on influent groundwater contaminant concentrations, water flow rate, and air flow rate. Past influent and effluent contaminant concentrations were used to calculate the operating efficiency of the presently configured system. Appendix B presents the system influent and effluent concentrations from 2004 to 2006. Calculations performed by EEEI to determine the effluent concentrations following construction of the three new extraction wells and the ability to meet permit requirements are also presented in Appendix C. Based on this modeling, the presently configured system can handle the influent waste stream after the additional three extraction wells are added. Modeled effluent concentrations and their comparison to NPDES limits are shown in Table 4-4.

4.7 Air Permit

Because the Beloit Corporation is an NPL-listed site, a permit is not required. Although the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) exempts CERCLA sites from obtaining permits for on-site actions, all remedial actions must identify and comply with (or explicitly waive) the substantive provisions of permit regulations that are determined to be Applicable or Relevant and Appropriate Requirements (ARARs). However, if a permit were sought, since the site does not automatically fall within the exemptions listed under 35 IAC 201.146, a letter of inquiry and Potential to Emit calculations would need to be submitted to the Illinois EPA, Bureau of Air, Air Permit Section, to obtain written determination from the Agency concerning permit status.

Based on the expected waste stream influent concentrations as presented in Appendix B, the total amount of VOCs emitted per year would be negligible: 544 pounds per year (see Table 4-5). Therefore, the Bureau of Air likely would determine an air discharge exemption.

I had also wondered how much it would cost to reduce this even further.

Table 4-1
Monitoring Well Survey Evaluation Results
Beloit Corporation Site, Rockton, Illinois

Well ID	Date	Time	Condition of Protective Cover, Cap, Lock	Condition of Cement Pad	Standing Water or Depressions	Condition/Type of Cap, Casing	Condition of Annular Space, Drain Holes	Well Depth (TOIC)	DTW (TOIC)
W26C	12/19/06	14:00	OK	None	--	Threads at TOC are chipped. No reference mark on TOC. Loose coupling approximately 1.5 feet below TOC.	OK, but no drain holes.	79.15	34.78
W2	3/30/07	–	Steel beam fell against well. Needs to be abandoned.		--				
W13	12/19/06	15:15	Damaged, well and protective cover bent approximately 45 degrees to east.						
W14	12/19/06	CNL							
W32	12/19/06	15:30	OK	Cracked	--	OK. J-plug cap.	OK, but no drain holes.	32.74	28.39
W28	12/19/06	15:35	Missing manhole cover.	Portions washed away.	--	Well TOC chipped. No reference mark on TOC. Cracked cap.	Gravel washed into annular space.	31.61	22.70
W15	12/19/06	15:50	Damaged, well and protective cover bent 15 degrees east.	None	--	TOC is approximately 3 feet below top of protective cover.	Cannot get visual on annular. No drain holes.	33.55 (top of protective cover)	24.15 (top of protective cover)
W1R	12/19/06	16:00	OK	None	Depression on west side of casing. Bentonite exposed.	OK	OK, but no drain holes.	27.73	20.56

Table 4-1
Monitoring Well Survey Evaluation Results
Beloit Corporation Site, Rockton, Illinois

Well ID	Date	Time	Condition of Protective Cover, Cap, Lock	Condition of Cement Pad	Standing Water or Depressions	Condition/Type of Cap, Casing	Condition of Annular Space, Drain Holes	Well Depth (TOIC)	DTW (TOIC)
G107	12/20/06	09:45	OK	OK	--	Original cap missing. Plastic sample bottle is currently used as replacement cap.	OK, but no drain holes.	50.84	41.89
G101	12/20/06	10:20	No protective cover. No lock.	None	--	OK	No protective cover, can't see annulus.	Root obstruction in well 42 feet from TOIC.	41.84
G108D	12/20/06	11:10	OK	Large cracks.	--	No cap. No reference mark on TOC.	OK, but no drain holes.	70.60	35.95
G108S	12/20/06	11:15	OK, but protective cover leans slightly to west.	Large cracks.	--	Tilt of protective cover prevents cap from fitting on well. No reference mark on TOC.	OK, but no drain holes.	42.73	36.52
W44C	12/20/06	11:40	Broken lid.	OK	--	OK. No reference mark on TOC.	Annular space is filling with leaves.	56.45	21.93
W18	12/20/06	11:45	OK	None	--	Casing wiggles at surface.	OK, but no drain holes.	78.43	25.55
G103D	12/20/06	11:50	OK	OK	--	Riser pipe is bent. No reference mark on TOC.	Water on cement, no drain holes.	49.45	24.01
W37	12/20/06	12:15	Broken lid (manhole needs special wrench to open).	OK	--	J-plug cap and lock in ice. No reference mark on TOC.	Annulus is filling with dirt and leaves.	38.24	28.85

Table 4-1
Monitoring Well Survey Evaluation Results
Beloit Corporation Site, Rockton, Illinois

Well ID	Date	Time	Condition of Protective Cover, Cap, Lock	Condition of Cement Pad	Standing Water or Depressions	Condition/Type of Cap, Casing	Condition of Annular Space, Drain Holes	Well Depth (TOIC)	DTW (TOIC)
P1	12/20/06	13:10	No protective cover, no lock.	Broken	--	Casing broken off at ground surface. J-plug cap. No reference mark on TOC.	Cannot see annulus.	20.11	9.89
G110	12/20/06	CNL—Based on map location, it is within footprint of 867 Prairie.							
G109	12/20/06	13:50	OK. Lid is bent, but lockable.	Cracked	--	J-plug. Obstruction approximately 2.95 feet BGS.	Cannot get water level indicator past the obstruction at 4 feet below TOC.		
W23B	12/18/06	10:15	Broken lid (manhole needs special wrench to open).	OK	--	No reference mark on TOC. J-plug cap.	OK. Dirt is filling in annular space.	49.60	25.98
W31C	12/20/06	15:20	OK (manhole needs special wrench to open).	Cracked	--	Could not open manhole to check lock, casing, annulus, depth to water, and total depth.			
W35C	12/20/06	16:15	Cover is broken and doesn't cover opening.	None	--	Casing cracked at TOC. J-plug cap. No reference mark on TOC.	Annular is filling in with dirt.	69.30	25.79
W24	12/21/06	08:10	OK	None	--	Gouges at TOC. No reference mark on TOC.	OK	Wet mass of roots and vegetation at 25.90 feet below TOIC.	25.90
W34	12/20/06	CNL—Buried under crushed gravel.							
W39	12/20/06	CNL—Buried under stored materials.							
W49C	12/20/06	Located, but could not open bolts on manhole cover.							

Key:

BGS = Below ground surface.
CNL = Could not locate.
TOC = Top of casing.
TOIC = Top of inside casing.
DTW = Depth to water.

Table 4-2
Extraction Well Construction Details

Well ID	Casing Diam. (inches)	Total Depth (ft)	Top of Screen (ft)	Screen Length (ft)	Screen Slot Size (inches)	Depth to Pump Intake (ft)
EW01	8.0	57.3	21.7	30.0	0.010	52.3
EW02	8.0	65.2	25.6	34.0	0.020	60.2
EW03	8.0	71.8	26.2	40.0	0.020	57.8
EW04	8.0	86.1	27.3	53.2	0.020	72.1

Table 4-3
National Pollutant Discharge Elimination System Permit No. IL0064564
for the Beloit Corporation – Blackhawk Plant
Coverage: Outfall 001 Discharge to the Rock River
Effective Dates: May 01, 2005 to April 30, 2010

Parameter	Load Limits (lbs/day)		Concentration Limits (mg/L)		Sample Frequency	Sample Type
	30-Day Average	Daily Maximum	30-Day Average	Daily Maximum		
Flow (MGD)	See Special Condition 1.				1/week	RIT*
1,2-Dichloroethane**	0.051	0.135	0.025	0.066	2/Month	Grab
1,1,1-Trichloroethane**	0.045	0.121	0.022	0.059	2/Month	Grab
Trichloroethylene**	0.053	0.142	0.026	0.069	2/Month	Grab
Tetrachloroethylene**	0.107	0.336	0.052	0.164	2/Month	Grab
1,2-Dichloroethylene**	0.369	1.18	0.180	0.574	2/Month	Grab
1,1-Dichloroethane**	0.045	0.121	0.022	0.059	1/Month	Grab
1,1-Dichloroethylene**	0.045	0.123	0.022	0.060	1/Month	Grab

*Recording, indicating, and totalizing.
**See Special Condition 8.

Special Condition 1. Flow shall be reported as a monthly average and daily maximum.

Special Condition 8. These parameters shall be reported in mg/L as a monthly average, and daily maximum concentrations are pounds per day (lbs/day) as monthly average and daily maximum loads.

Key:

MGD = Millions of gallons per day.
mg/L = Milligrams per liter.

Table 4-4
Summary of Existing and Future Influent and Effluent Concentrations
Former Beloit Corporation - Blackhawk Facility
Rockton, Illinois

Chemical	Influent				Effluent				NPDES Limits	
	Existing		Future		Existing		Future		30-Day	Daily
	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum
1,1,1-Trichloroethane	1.9	3.4	3.2	100.0	0.3	1.0	0.6	0.8	22	59
1,1-Dichloroethane	ND	ND	0.5	0.5	ND	ND	0.1	0.1	22	59
1,2-Dichloroethane	ND	ND	0.4	0.4	ND	ND	0.0	0.0	25	66
Tetrachloroethene	50.7	130.0	357.1	420.7	0.8	2.5	31.6	37.2	52	164
Trichloroethene	2.2	5.3	9.4	11.9	0.3	2.5	1.9	2.4	26	69
1,1-Dichloroethene	0.7	1.0	1.1	1.3	0.3	0.3	0.1	0.2	22	60
cis-1,2-dichloroethene	1.0	2.5	98.7	100.0	0.3	1.0	11.1	11.3	NE	NE
trans-1,2-dichloroethene	ND	ND	1.8	1.8	ND	ND	0.2	0.2	NE	NE
total 1,2-dichloroethene	1.0	2.5	100.6	101.8	0.3	1.0	11.3	11.5	180	574

Note: All concentrations are in micrograms per liter.

Key:

NPDES = National Pollutant Discharge Elimination System.
ND = Not detected.
NE = Not established.

Table 4-5
Summary of Air Discharge (Worst Case Scenario)
Former Beloit Corporation - Blackhawk Facility
Rockton, Illinois

Chemical	µg/day	lbs/day	lbs/year	tons/year
1,1,1-Trichloroethane	5,123,982	0.01	4.13	0.002
1,1-Dichloroethane	579,923	0.00	0.47	0.000
1,2-Dichloroethane	495,986	0.00	0.40	0.000
Tetrachloroethene	484,800,968	1.07	391	0.195
Trichloroethene	13,712,873	0.03	11.05	0.006
1,1-Dichloroethene	1,544,886	0.00	1.25	0.001
cis-1,2-Dichloroethene	115,194,143	0.25	92.87	0.046
trans-1,2-Dichloroethene	2,113,665	0.00	1.70	0.001
Total VOCs	**623,566,426**	**1.37**	**503**	**0.251**

Key:

µg/day = Micrograms per day.
lbs/day = Pounds per day.
lbs/year = Pounds per year.
VOCs = Volatile organic compounds.

5 Proposed Design of Treatment Systems

For the system design, EEEI prepared a Technical Memorandum entitled *Equalizing Flow Pressure* (EEEI 2007b). The Equalizing Flow Pressure Technical Memorandum was prepared to investigate an observed flow rate drop from incoming force mains to the influent header. Subsequently, design calculations by EEEI showed that a pressure differential between the incoming force mains proved to be the reason for the underperformance of the existing wells. EEEI's Technical Memorandum described the options for correction of this problem in detail, with the ultimate selection of the preferred design changes. The options for equalizing pressure within the treatment system included the following: sizing all pumps to achieve equal pressure at the manifold, sizing pumps to achieve an equal pressure within two or more manifolds with separate connections to the air stripper; or installing an equalization tank with a transfer pump supplying the existing single manifold to the air stripper. It was concluded that installing an equalization tank provided the most flexibility for future system modifications and increased the sustainability of the system. This technical memorandum is included as Appendix D.

To house the rectangular steel equalization tank, the design of the proposed treatment system includes the addition of a new pre-assembled, all steel building, which will be added onto the existing treatment building. Additionally, three new extraction wells, an influent transfer pump, and a sump pump will be added to the system as well. All of the existing force mains from the four extraction wells and the force mains from the new extraction wells will be routed to the new steel tank. Six groundwater monitoring wells (three sets of two nested wells) will also be constructed. Sheets 1 through 9 of the 95% Remedial Action Design Drawing Set are attached (half-size) to this report as Appendix E, and depict the proposed system modifications.

5.1 Groundwater Extraction Wells

Sheet 3 of the Design Drawing Set in Appendix E shows the proposed configuration of the groundwater extraction wells and trenching locations to connect force main and electrical conduit runs to the building extension. The extraction well locations are based on the modeled results presented in Section 3 of this report. This configuration will limit the amount of trenching within the existing truck routes and decrease the disturbance to facility operations during construction. The exact locations in northing and easting coordinates for extraction wells and monitoring wells are shown on Sheet 4.

Based on the SAI and modeling results in Section 3, pneumatic fracturing will be used to increase groundwater extraction rates at the Beloit site. EEEI has successfully implemented pneumatic fracturing at several other sites in Illinois to enhance permeability in formations and improve subsurface flow.

Pneumatic fracturing (U.S. Patent #5,032,042) is the injection of gas at high pressure and flow into soil or rock matrices in order to create fractures or fissures. Fractures or fissures occur when the pressure of the injected gas exceeds the natural in situ stresses, and the flow rate exceeds the natural permeability of the soils. In soil formations, pneumatic fracturing enhances permeability by creating fracture networks; in rock, the effect is dilation and extension of existing discontinuities, thereby improving the interconnection between existing fractures. The immediate benefit of pneumatic fracturing is improved access to subsurface contaminants so that liquids and vapors can be transported and extracted rapidly, which results in a cost savings during the installation and operational phases of a remediation project. Another advantage of pneumatic fracturing is that it can be applied within existing remedial systems as an enhancement and beneath or adjacent to existing structures and/or utilities.

At locations where a new/additional groundwater extraction well will be installed, fracturing will be performed prior to installing the well. First, an open borehole will be installed using 4-inch-diameter flight augers to an approximate depth of 60 feet BGS. The top 25 feet of the borehole will have a temporary casing installed to prevent formation collapse in the loose soils across that range. A packer system will be used to isolate 3-foot intervals so that short bursts (~20 seconds) of compressed air (less than 200 pounds per square inch) can be injected into the interval to fracture the formation starting at 27 feet BGS and continuing to 57 feet BGS. Once a 3-foot interval is fractured, the equipment will be relocated within the borehole, and another interval will then be fractured. A total of 10 fracture intervals will be performed for each well.

Once fracturing is completed, the existing borehole will be widened to a diameter of 13.5 inches. After the borehole has been expanded, a vacuum and/or pressure will be applied to the borehole to reestablish the fracture pathways and ensure connection of the fractures to the extraction wells. This redevelopment is a necessary component of the well installation. Fracturing technology is limited by the size of the borehole. For the Beloit site, it has been determined that the extraction wells should be installed in 13.5-inch-diameter boreholes. However, fracturing equipment limits the size of the boring to an approximate 5-inch-diameter opening. In order to fracture and optimize the well size, well redevelopment has been identified as a necessary component.

New wells will be installed to match the previously installed extraction wells. This requires an 8-inch-diameter casing for all three wells. All wells will be installed with 35-foot screens from 25 to 60 feet BGS. All pumps will be installed approximately 5 feet from the bottom of the wells. The extraction wells have been designed for removal flow rates of 14 gpm for EW05, EW06, and EW07. Sheet 4 shows the extraction well design. Protective concrete bollards will be installed around all new wells.

Standard dimension ratio (SDR) 9 HDPE was used for the existing force mains feeding the P&T system. SDR 9 will be retained as the pipe class used for force mains. SDR 9 has a maximum working pressure rating of 200 psi.

5.2 Treatment Plant Pump Sizing

There are two new pumps required within the P&T plant based on proposed design changes to the overall system. An influent transfer pump and a sump pump will be located within the building extension.

5.3 Treatment Building

The new treatment building dimensions will be 14 feet by 20 feet. The building will be located adjacent to the existing P&T treatment building and will share one wall. A man door will connect the interiors of both buildings and an overhead door will give access to the building along one side. The foundation has been designed by EEEI and the building manufacturer will provide the locations necessary for building tie-downs. The roof line of the new building will be perpendicular to the existing building to eliminate a trough where snow can accumulate. All tie-ins to the existing building, including extending the new roof ridge line to the existing building, will be made by the building manufacturer.

The selected building will arrive at the site pre-assembled and pre-wired. It will contain a heater, exhaust fan, and interior lighting. The building is considered a long-lead time item and requires approximately 14 weeks of lead time for delivery to site.

5.4 Influent Tank

The influent (equalization) tank will be 12 feet in length, 8 feet in width, and 6 feet in height. The dimensions of the tank will allow it to fit within the specified building and to have a capacity between the high and low level switches of approximately 3,000 gallons. The tank will contain flanged openings for the influent force mains, vent, transfer pump, sump pump, and level controls. A 30-inch-diameter manway will be installed for inspection and cleanout. The steel tank is also considered a long-lead time item, requiring 12 weeks of lead time for delivery to the site.

5.5 Groundwater Treatment System Upgrades

To date, most necessary upgrades to the system as outlined in the Remedial Design Work Plan (E & E 2006) have been accomplished. BES has replaced the effluent transfer pump and has overseen repair of the plant electrical feed and air stripper sump float control. The effluent line has had three manholes added and was subsequently inspected. The effluent pipeline has been found to be clogged and is in need of repair. The material plugging the piping is unable to be removed and will require sections of pipe to be replaced.

The findings based on modeling performed following the ISCA EE indicate that the current system has sufficient capacity to treat the increased mass loading of water introduced from the new extraction wells. The plant will also meet current Illinois EPA air discharge requirements for a remedial treatment system, and is physically capable of meeting the increased flow rate through the system based on motor and piping sizes. Therefore, the only changes required are based mainly on achieving a safer work environment, protection of system components, and tie-in of new extraction wells. These changes are detailed below.

A sump cover will be fabricated for the existing building to ensure the safety of personnel working within the P&T building. The open control wiring conduit box on the sump control will also be repaired. To prevent continuing plant operation in the case of a pipe leak or burst, the sump level switch will be made operational.

Sheet 9 shows the new Piping and Instrumentation Diagram (P&ID) configuration following remedial design upgrade implementation. Completion of the treatment plant upgrade will entail additional programming for the PLC. Specifically, the new extraction wells, influent tank level controls, influent transfer pump, and sump level controls will require programming. The existing extraction wells will require programming changes since the current programming requires EW03 and EW04 to be running for the air stripper to run. If EW03 and EW04 are not running, the plant will shut down, making it impossible to take these wells off line using the current program.

5.6 Monitoring Well Upgrades

Under the selected site remedial alternatives, several monitoring wells will require upgrades and some will be slated for abandonment. If a well is slated for abandonment, the well or piping will have all exposed portions removed to a depth of 2 feet BGS. All bollards and concrete pads will also be removed. The remaining piping will then be filled with bentonite-cement slurry, and the open end will be capped. The areas around each well will then be backfilled to a level even with the existing ground surface. Specifications for well abandonment have been prepared as part of the design.

Based on the location of new extraction wells, additional monitoring wells will be constructed in order to monitor source area plume concentrations and pumping effects through the observed cone of influence. The locations of the new monitoring wells were determined based on achieving these goals, which entailed placing the new monitoring wells close to and generally upgradient of the extraction wells. The remedial design documents contain monitoring well locations and construction criteria as shown on Sheet 4 of the Design Drawing Set. Determinations have been made based on the new monitoring well locations as to the need for above-grade (stick-up) or flush-mount completions. Protective concrete bollards will be placed around all wells completed above grade.

6 Additional Considerations

6.1 Health and Safety

Each contractor and/or subcontractor working on site will prepare a site-specific health and safety plan to govern their activities in relation to the specifications. The CHSP will be required in accordance with Occupational Safety and Health Administration Standards and Regulations contained in 29 Code of Federal Regulations (CFR) 1910 and 29 CFR 1926. Each plan will specifically identify the person with authority to stop work at the site.

Trenching activities will not require entering a trench greater than 5 feet deep. It is anticipated that construction activities will require entering a trench less than 5 feet in depth, which will include the following activities, at a minimum:

- Making pitless adapter connections to wells EW05, EW06, and EW07; and
- Performing force main and electrical conduit connections at the building foundation.

The safety of personnel in excavations is regulated by the Occupational Safety and Health Administration (OSHA) as specified in 29 CFR 1926.650-653. OSHA dictates standards for shoring, sloped sidewalls, hazardous atmosphere, access, and other aspects of excavation projects. The regulations dictate that personnel entering an excavation over 5 feet in depth work under an OSHA Safety Plan; that a minimum number of daily inspections of trenches and shoring are performed; and that an OSHA-defined Competent Person remains on site at all times when personnel are in trenches. OSHA regulations will be followed at all times throughout the construction process. The Contractor will verify conformance with these regulations.

Proper hoisting and lifting operations will be important to worker safety. Hoisting and lifting operations will take place on many occasions, including:

- During loading and unloading of materials and equipment;
- While setting the equalization tank in place; and

- During placement of the pre-fabricated steel building and assembly of building roof and wall tie-ins.

6.2 Site Security

The selected remedial action contractor will be responsible for site security and for protection of their equipment and materials that are stored on site.

6.3 Purge and Decontamination Water

All purge and decontamination water will be run through the current pump-and-treat system for treatment and ultimate discharge to the Rock River.

6.4 Off-Site Borrow Materials

Approved off-site borrow materials will be required for many of the components of the final remedial action. The selected remedial action contractor will meet the specifications required for borrow material. Borrow material will be tested for polychlorinated biphenyls (PCBs), VOCs, semivolatile organic compounds (SVOCs), and metals concentrations greater than Tiered Approach to Corrective Action Objectives (TACO) Tier 1 residential standards. The contractor will submit borrow material samples and their testing results to the Illinois EPA. The source of borrow material will be made available for inspection by Illinois EPA, or another source will be found.

6.5 Disposal, Emission, and Discharge Requirements

Drill cuttings will be generated during the installation of new groundwater extraction and monitoring wells. All drill cuttings will be containerized and sampled for disposal analysis. The container holding any drill cutting materials will be labeled and dated while awaiting final disposition in accordance with Resource Conservation and Recovery Act (RCRA) requirements. It is currently anticipated that drill cuttings may be disposed of in a non-hazardous landfill. Concrete bollards, well casings, and other materials removed from abandoned wells and generated during remedial design construction activities will be staged on site until they can be transported to an off-site construction debris landfill. No permit-required emissions are expected during site construction activities. Purge and decontamination water will be handled as detailed in Section 6.3.

6.6 Site Survey

A site survey will be completed at the conclusion of all field activities and will include the locations of new extractions wells and monitoring wells constructed as part of the remedial design. Additionally, existing monitoring wells that have had repairs completed will be surveyed, and the north side of the well casing will be marked for future water measurements.

6.7 Permits and Access Agreements

It will be the remedial action contractor's responsibility to obtain the permits and access agreements needed for construction. Permits may include City of Rockton Construction Permits, City of Rockton Building Permits, State of Illinois Drilling Permits, and utility clearances.

6.8 Operations and Maintenance

EEEI will prepare an O&M plan to cover implementation and long-term maintenance of the Remedial Action. The O&M Plan will incorporate all pertinent operational requirements of the ISCA pump-and-treat system and requirements for long-term groundwater monitoring. The intent of the O&M plan is to maximize the on-line operational time and performance of the treatment system. The O&M plan will supersede any existing plans.

EEEI will prepare an O&M manual to provide technical information to assure:

- Effective and efficient operation of the site remedy;
- The site remedy is monitored for performance and effectiveness; and
- All parties are aware of the specific O&M needs of the site/process.

Key items associated with the O&M plan include the following:

- **Weekly Operation and Maintenance and Reporting.** This includes coordination with the Engineer, mobilization, demobilization, system review, system adjustments, general and preventive system maintenance, and reporting of immediate repairs to the operating treatment system.
- **Monthly Operation and Maintenance, Sampling, and Reporting.** This includes coordination with the Engineer, mobilization, demobilization, system review, system adjustments, general and preventive system maintenance, sampling of regulatory discharges, and reporting of the system checks, flow information, and immediate repairs to the operating treatment system.
- **Unscheduled System Maintenance and Reporting.** This includes mobilization and demobilization to handle and maintain unscheduled treatment system shutdowns as required, and communication and coordination with the Engineer. This also includes the evaluation of system problems and the ability to restart the system and continue treatment of the environmental waste streams.
- **System Startup and Monthly System Review and Evaluations.** Restart the air stripper and groundwater extraction pumps to evaluate equipment performance on a monthly basis.

In addition to the items listed above, EEEI will develop multiple checklists, which will document the inspections and pertinent system operational data to allow for a

thorough evaluation of system performance, as well as identify potential modifications to the operations to increase its operational efficiencies.

The O&M manual will be one complete, stand-alone document that can be implemented by individuals with limited familiarity with the site/process. The relevant portions of the documents referenced in the O&M manual (such as manufacturers' O&M manuals, shop drawings, engineering specifications, and relevant and appropriate requirements of regulatory agency regulations and documents) will be incorporated in the O&M manual as appropriate.

The Guidance Document EPA/542/R-05/010, *O&M Report Template for Ground Water Remedies (with Emphasis on Pump and Treat Systems)*, will be used in the writing of the O&M Plan. A draft O&M Plan will be submitted for written comments as a pre-final 95% Design Document submission. Comments from Illinois EPA will be incorporated into a final ~~O&M Plan~~, and three copies of the document will be submitted for distribution. The O&M Plan will be written to include changes that will be made to the system following implementation of the Remedial Design. Following implementation of the Remedial Design, ~~the O&M~~ Plan may require minor revisions.

and as built drawings will be incorporated

That means it is in this document right

7 References

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__________, 2006, *Remedial Design Work Plan, Beloit Corporation Superfund Site, Rockton, Illinois*, July 2006.

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Illinois Environmental Protection Agency (Illinois EPA), 2004, *Illinois EPA Superfund Record of Decision, Beloit Corporation, IEPA ID: L 2010355004, Rockton, Illinois*, September 2004.

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U.S. Environmental Protection Agency (EPA), 2005a, *Guidance Document: O&M Report Template for Ground Water Remedies (with Emphasis on*

Pump and Treat Systems), Office of Solid Waste and Emergency Response, Washington, D.C., EPA/542/R-05/010, April 2005.

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__________, 1995b, *Guidance for Scoping the Remedial Design,* Washington, D.C., EPA/540/R-95/025, March 1995.

A Response to Illinois EPA and EPA Comments

April 18, 2007

VIA ELECTRONIC AND 1ST CLASS MAIL
Eric Runkel
Illinois Environmental Protection Agency
Burea of Land
Springfield, IL

Re: USEPA Review of 30% Remedial Design Document for Beloit Corporation Superfund Site

Dear Eric:

I have reviewed the above referenced 30% design document dated April 2007 and have the following comments:

Section 1.1 Purpose of the Design Report

Last paragraph on page 1-2: The second sentence of this paragraph says that RD documents will be comprehensive and complete so that bidding packages can be prepared and provided to remediation contractors. I suggest that you have the design contractor prepare the bidding packages as part of the design. If you choose not to incorporate this modification, then I want to know who will prepare the bidding packages and when.

E & E response: This section as been revised to indicate that the Illinois EPA will hold the contract with the selected remedial contractor, who will be one of the Illinois EPA Corrective Action Contractors.

Also, I propose that you add into this section a specific requirement that all calculations and drawings will be certified and signed by a Registered Professional Engineer.

E & E response: The Final 100% Design Specifications will be signed by a Registered Professional Engineer.

Section 2.8 Scope of the Final Remedial Action

The ROD requires institutional controls be placed on the Beloit property until the groundwater is restored to the more stringent of MCLs of State of Illinois Class I standards and for MNA in Blackhawk Acres until these goals are met. Who is going to be responsible for placement of these institutional controls. I am doing this for a site in Wisconsin and it requires and Easement and Restrictive Covenant to be prepared and filed with the County. Why don't you have your remedial design contractor draft the easement and restrictive covenants so that we can easily file it with the County. If you do not agree to this modification, then I want to know who will do that and what is the schedule for this item.

This section suggests that the goals of the RA are to be MCLs or Class I standards across the whole site. However, later in the report where it discusses the goals of the enhanced ISCA, these goals are not stated.

E & E response: Section 3.1 has been revised to specifically reference the appropriate standards.

Chapter 3: Groundwater Treatment Zone Delineation and Well Layout

The second paragraph states that this work was done in accordance with the Illinois EPA-approved work documents, field sampling plan, and QAPP prepared by E&E. I think that we should state specifically in this section that the QAPP was approved by the USEPA Qapp

Reviewers because as you know, all QAPPs must be approved by USEPA.

E & E response: A sentence has been added stating that the QAPP was approved by EPA.

Groundwater modeling section of Chapter 3: While I reviewed this section of the report I would like to submit this section to the Superfund Field Support Services team for their hydrogeologist's review and I request that their comments and concerns be addressed prior to submission of the 95% design.

E & E response: Responses to specific groundwater model comments are provided in another comment letter.

Figure 3-1 - Extent of PCE contamination: I question the southeastern edge of the PCE plume boundary. There are no monitoring wells in this area but the plume mysteriously stops at the Beloit Corporation property line. What information did they rely upon to determine this edge of the plume. We know that the contamination extends into the southwestern corner of the Blackhawk Acres subdivision yet we show the plume boundary stopping at the property line.

E & E response: The figure shows only the PCE plume greater than 5 ug/L (the MCL). Concentrations below the MCL extend into the Blackhawk Acres, but are not shown on this figure.

Section 4.6 NPDES Permit

The first paragraph of this section states that the treated groundwater is discharged to the Rock River under a NPDES permit that will expire in three years. Then it states that the treatment plant must operate in a manner that meets the requirements of the NPDES permit as reported on the DMRs. What are DMRs? Are they the Discharge Monthly Reports? What happens when we modify our system and add additional elements to the discharge? I understand that we have done mass balance calculations to show that the additional load will not exceed the discharge requirements but don't we have to submit these calculations to the people who approve NPDES permits to obtain their agreement? Also, what happens in 3 years when the current permit expires? Why don't we just go ahead and have the design contractor prepare the necessary submission to the NPDES permitting authority and we obtain either a revised permit with a longer effective period or a Substantial Discharge Requirements letter from them which agrees to our modifications and reiterates the substantive requirements for us at this Site. This section really leaves me wondering who is going to have to deal with these issues in a couple years and I foresee problems if we don't engage the NPDES permitting people at this stage.

Since this is a Superfund Site, of course we do not have to obtain permits, but we customarily ask that the permitting authorities give us a Substantial Discharge Requirements (SRD) letter . I propose that you have your design contractor prepare the letter of inquiry to the NPDES Permitting Section and include all necessary calculations and information for them to make a determination and while they are at it, have them submit the letter of inquiry and incorporate the requirement for them to obtain an SRD letter for inclusion into the final design.

E & E response: E & E will communicate with the NPDES Permitting Section if requested by Illinois EPA.

Section 4.7: Air Permit

This section ends with the statement that since the total amount of VOCs emitted per year would be begligible (544 pounds per year) that the Bureau of Air likely would determine an air discharge exeption. This bothers me for the same reason as the NPDES permit bothers me although this section does go on to state that a letter of inquiry would need to be submitted to the Illinois EPA, Bureau of Air Permit Section do obtain written determination concerning permit status. I believe what we need to obtain from the Bureau of Air is a Substantial Discharge Requirements (SRD) letter similar to the SRD letter that we seek from the NPDES Permit Section. Since this is a Superfund Site, of course we do not have to obtain permits, but we customarily ask that the permitting authorities give us an SRD letter. I propose that you have your design contractor prepare the letter of inquiry to the Air Permitting Section and include all necessary calculations and information for them to make a determination and while they are at it, have them submit the letter of inquiry and incorporate the requirement for them to obtain an SRD letter for inclusion into the final design.

E & E response: E & E will communicate with the Bureau of Air Permit Section if requested by Illinois EPA.

Table 4-1: Monitoring Well Survey Evaluation Results

Why can't I see any X-Y coordinates for these wells? Will this be included later in the Site Survey? Was the information collected or estimated? Please let me know how I can obtain the X-Y coordinates for the monitoring wells.

E & E response: Coordinates for these wells will be confirmed later in the site survey, as stated in Section 6.6. Coordinates for existing wells are provided in the RI Report.

Table 4-2: Extraction Well Construction Details

Why can't I see any X-Y coordinates for these wells? Will this be included later in the Site Survey? Was the information collected or estimated? Please let me know how I can obtain the X-Y coordinates for the extraction wells.

E & E response: Coordinates for these wells will be confirmed later in the site survey, as stated in Section 6.6. Coordinates for existing wells are provided in the RI Report.

Section 6.1 Health and Safety

All Site specific Health and Safety Plans that are submitted by subcontractors should also specifically identify which person has the authority to stop work at the Site. I suggest that you add a sentence to that effect in the section on Contractor Health and Safety Plans.

E & E response: A sentence has been added to this effect.

Section 6.8: Operations and Maintenance

The very last sentence of this section states that folling implmentation fof the RD, the O&M plan may require minor revisions. I propose that you add to this sentence the requirement for the RA subcontractors to make these revisions and to provide "As-Built" Drawings to be incorporated into the Final O&M Plan and that all these drawings are to be certified by a Registered Professional Engineer.

E & E response: The scope of work will be revised to include record drawing requirements (for legal reasons we don't use the term as-builts).

In the interest of saving time I am going to send these comments to you today but I advise you that I am submitting the modelling section of the document to our hydrogeologists for their review and I request that you have your contractor address their concerns prior to submission of the Final Remedial Design.

Sincerely,

Jon Peterson
Remedial Project Manager

RESPONSE TO USEPA COMMENT:
GROUNDWATER TREATMENT ZONE DELINEATION AND WELL LAYOUT
REMEDIAL ACTION 30% DESIGN REPORT
BELOIT CORPORATION

General comment from Dr. Luanne Vanderpool, USEPA Advanced Analysis & Decision Support Section, R5:

I concur with the proposed additional extraction wells. The two additional wells as well as the relocation of one of the original wells will greatly improve the performance of the pump and treat remedy. As I previously have communicated to you, the suggestion for enhancing hydraulic conductivity by hydraulic fracturing in the immediate vicinity of the extraction wells is questionable. I strongly urge a cost benefit analysis be done to determine if the potential hydraulic conductivity enhancement (that is not assured) will reduce the time frame for cleanup enough to justify the additional cost of doing the hydraulic fracturing.

Response: Additional text has been added to Section 3.7 that provides additional evaluation of potential benefits of fracturing and the performance of a cost benefit analysis during future design phases.

Specific comments:

1. *Section 3.3, Model Construction, Observation Wells, Page 3-3*
   Reference is made to water levels provided on Table 3-1. Table 3-1 in the report does not provide water levels. This absent table is again referenced on page 3-5, last paragraph of the boundary conditions subsection.

   Response: Table 3-1 has been included.

   It is stated that 8 monitoring wells were selected to serve as observation wells and to be used during calibration. Are 8 wells all that exist? If more exist, what was the rationale for selecting these wells? All wells located within the model domain, screened in the intervals being modeled should be used.

   Response: There are 14 monitoring wells in the modeling domain. Originally, 8 water table wells were used during calibration. One additional well has been added (W21), for a total of 9 water table calibration wells. Well locations are shown on revised Figure 3-8. Five wells within the model domain were not used for the following reasons: W23B (deep well nested with water table well W23 [used in calibration]); wells W31C and W41 (pre-ISCA RI water level data is limited and potentially non-representative), well W35C (deep, non-water table well), well W39 (water level only 0.2 ft. different than W40 and in the same general area. W40 selected to represent Beloit Plant upgradient conditions).

2. *Section 3.3, Boundary Conditions, Pages 3-4 and 3-5*
   The model appears highly constrained with no natural boundaries (the model domain does not extend as far as the Rock River, so the river nodes are artificial) and a considerable portion of the boundaries constant head boundaries. It is mentioned in Section 3.4 that boundary conditions were adjusted during calibration but that is not discussed at all. Ideally the extent of the model would expand outward so that the extent of the model domain coincides with physical features of the ground water system which are then represented as the domain boundaries. When artificial boundaries are used they must be carefully evaluated to determine what error this causes to the model and this should be discussed in the modeling report.

   Response: The Rock River was included in the model along the western boundary and portions of the northern boundary (see Figure 3-6) and was discussed on page 3-5.

3. *Section 3.4, Model Calibration*
   While the calibration appears acceptable, there are very few calibration targets. Figure 3-8 shows 5 monitoring wells that were not part of the calibration; why weren't they used? The few calibration targets is a significant source of uncertainty.

   Response: Please see response to Comment #1 above.

4. *Section 3.5, Sensitivity Analysis, Page 3-7*
   Specify the range over which river bed leakage values were varied. and provide justification (here or in Section 3.3) that the range tested is reasonable for the site conditions. (Citing modeling done by someone else is not adequate justification; citing the rationale used by the previous modeler may be adequate justification.) The sensitivity of the model to the constant head boundary values should also have been tested.

   Response: In the RI, the leakage factors (river bed hydraulic conductivity /bed thickness) were based on an assumption that the nodes immediately upstream of a dam would have a thicker river bottom sediments and lower river bed conductivities. Values for the river bed conductances were based on literature[1] and calibration efforts. The values used ranged from 0.0035 day^{-1} near the dam to 0.283 day^{-1} upstream of the site. The model domain for the extended extraction well system included an upstream section of the river and a leakage value of 0.23 day^{-1} was used. However, as stated in the text, increasing or decreasing the river bed leakage value within this range had little or no effect on model simulations.

---

[1] Rorabaugh, M.I. 1951, Stream-Bed Percolation in Development of Water Supplies. Trans-General Assembly Brussels International Arrow Science Hydrology, V2 pp. 165-174

Norris, S.E. and Eagon, H.B., Jr 1971, Recharge Characteristics of a Water-Course Aquifer System at Springfield Ohio, Groundwater V9 No.1 pp 30-41

Warzyn Inc. 1986, Remedial Investigation of the Wausau Well Field.

Sensitivity of the model to the constant head boundary values was performed during model calibration. During the calibration process adjustments to the constant head values were made within reasonable ranges around the average water table elevations measured before ISCA operations began, in wells located near the model domain boundaries. These trial-and-error adjustments were made until a reasonable match between the observed and simulated flow field within the domain was obtained.

5. *Section 3.6, Evaluation of Existing ISCA P & T System*
   Discussion during the briefing implied that modeled heads simulating operation of the ISCA P & T were compared to actual measured heads. There is no mention in this section of doing that. This comparison would help to validate the model and should have been included in the report.

   Response: Text will be added to Section 3.6. Modeled drawdown in extraction well EW01 was 18.05 ft. during simulated pumping at a time averaged rate of 10 gpm. This is comparable to an actual drawdown of 19.3 ft. measured in EW01 while pumping at approximately 16 gpm during the Source Area Investigation short-term pump test (Technical Memorandum, Source Area Investigation, Beloit Corporation Superfund Site, Rockton, Illinois. E & E, February 2007). The favorable comparison of model results to field observation provides a measure of verification and results in a higher degree of confidence in model predictions.

6. *Absent from this modeling report is a discussion of the model limitations and sources of uncertainty. Such a discussion should be included.*

   Response: Additional text has been added to Section 3.5 Sensitivity Analysis.

   Because the aquifer system being modeled is heterogeneous, there is uncertainty inherent in the representation of complex and variable geologic and hydrologic conditions with a finite mathematical model. Sensitivity analysis was used in the calibration process to identify those parameters that are the most important to model reliability. The purpose of the sensitivity analysis was to identify the uncertainty in the calibrated model caused by uncertainty in the estimates of aquifer parameters and other inputs. All geologic and hydrologic inputs, e.g., lithology, thickness, continuity, hydraulic properties, water sources and sinks, were considered to have some degree of uncertainty, however the parameters selected for sensitivity analysis were those that would have the greatest affect on potential changes in hydraulic head and the ability of the model to simulate the physical hydrogeologic system. Although all input parameters were varied to some degree during trial-and-error calibration of the model, the primary parameters identified for sensitivity analysis were the hydraulic conductivity, rainfall recharge, and river bed leakage.

7. *Table 3-1 and Table 3-2 and Section 3.6*
   a. *A retardation factor (4.3?) is assumed. Provide rationale for this assumption.*

Response: USEPA's On-line Tools for Site Assessment Calculation-Retardation Factor (http://www.epa.gov/Athens/learn2model/part-two/onsite/retard.htm) was used in conjunction with data from the RI. Inputs were as follows:

Porosity: 0.2 from RI;
Fraction Organic Carbon : 0.002 from RI;
Chemical Data Source: Illinois EPA, Risk Based Cleanup Objective Part 742 TACO
Chemical: PCE
Default Parameters: Solids Density (2.65), Koc 155 L/Kg

The retardation factor determined by the USEPA On-line Tools Assessment Calculation and used in the model (4.3) was comparable to the retardation factor of 5.3 calculated and used in the RI.

b. *A constant thickness for the aquifer is assumed. Yet in the flow path modeling, the domain was divided into three areas with differing aquifer bottom elevations. Explain this and justify the use of the constant aquifer thickness in the table calculations.*

Response: The most contaminated portions of the plume, Zones A and B, and a large portion of Zone C are located above the aquifer bottom elevation of 680. Peripheral areas are transitional to elevations 670 and 690. A constant bottom elevation of 680 provided a good approximation for calculation of the thickness of the aquifer in areas requiring cleanup.

c. *Why are the zones assumed to be circular? The actual plume is not portrayed as circular (Figure 3-1), nor are the proposed extraction wells located as if the system is conceptualized as circular.*

Response: Although the actual plumes are only roughly circular, the use of the circle was a conservative approximation intended to facilitate calculation of surface areas and volumes of contaminated groundwater for the pore volume removal calculation.

d. *Add text explaining how the zones are defined (e.g. that Zone C does not include the area within Zone B).*

Response: Text has been added to both tables.

e. *Add text explaining how the withdrawal rates for each zone are estimated.*

Response: Text has been added to both tables.

8. *Table 3-1 and Table 3-2*
   a. *There are errors in the calculation of surface areas which result in Surface Areas in the tables being about twice as large as they really are.*

b. *There are errors in the calculation of "Minimum Number of Pore Volumes Required to Reach MCL".*

c. *There appears to be errors or inconsistencies in withdrawal rates used in the spreadsheet.*

   i. *In table 3-1, there is a withdrawal rate of 5 gpm in Zone A, a withdrawal rate of 5 gpm in Zone B and a withdrawal rate of 10 gpm in Zone C; yet the total withdrawal rate is only 15 gpm. Either explain or correct the table.*

   ii. *In Table 3-2, footnote 2 states that the Zone B withdrawal rate is approximately 7.5 gpm from EW06 and 7.5 gpm from EW07 (for a total of 15 gpm) but in the spreadsheet the withdrawal rate is 30 gpm.*

   iii. *In Table 3-2, footnote 2 states that the Zone C withdrawal rate is approximately 7.5 gpm and 12.5 gpm (for a total of 20 gpm), but in the spreadsheet the withdrawal rate is 42 gpm.*

Response: Each of these errors have been corrected. Tables 3-2 and 3-3 have been consolidated into one table- now Table 3-2. For clarification, this table has been revised to include cleanup time estimates under various extraction scenarios only for the plume as a whole (area where PCE exceeds the MCL of 5 ug/L).

VIA FACSIMILE AND 1ST CLASS MAIL

<u>September 28, 2007</u>

Eric Runkle
Illinois Environmental Protection Agency
Bureau of Land – National Priorities Unit
1021 North Grand Avenue East,
P.O. Box 19276
Springfield, Illinois 62794-9276

Re: <u>Beloit 95% Remedial Design Comments from USEPA</u>

Dear Eric:

I have reviewed the 95% design submittal and I have the following comments that will have to be addressed and incorporated in some fashion into the final design document and which can relied upon to establish the Administrative Record for the remedial actions that IEPA will be undertaking using USEPA funds.

First, in Section 1.2 – the definitions section, there are several instances where it refers to the Lake Calumet Site. Please ensure that there are no errors of this type in the final submittal.

Response: All references to the Lake Calumet Site will be removed from the 100% design.

All of the groundwater modeling discussions including, but not limited to, the contents of the 30% design submittal, the responses to comments on the model that took place in several letters and emails and a powerpoint presentation have got to be wrapped up into a final deliverable that may be an appendix to the Remedial Design or a separate submittal such as a tech memo. To be more clear about the contents of this appendix or tech memo, the 30% design submittal contained a detailed discussion of the modeling that was conducted to justify the selection and placement of new extraction wells. Then there was discussion with our modeler, Dr. Luanne Vanderpool and our USGS contact, Bob Kay regarding the accuracy of the model and several response to comments letter were prepared and a powerpoint presentation submitted to satisfy the comments of our reviewers. These included clarifications, citations of research articles and experience at other sites and went so far as to include a cost-benefit analysis which formed the basis for our decision to sign the Explanation of Significant Differences. I want to make sure that we have a final documents that ties all of that discussion together and puts it into a standalone document or appendix.

Response: The 100% design documents are for bidding (if it were to occur) and construction purposes. . The inclusion of modeling discussions and/or justifications into a construction document would be inappropriate. Therefore, a Design Analysis Report providing the requested information (with the exception of the Powerpoint presentation, which would be redundant information) will be prepared and submitted before the 100% design.

The Scope of Work section 1.3 doesn't include a requirement to provide as-built drawings that we will ultimately need for the Final O&M Plan and the Remedial Action Completion Report and I want you to ensure that the work requires submission of all components necessary for those deliverables.

Response: The scope of work will be revised to include record drawing requirements (for legal reasons we don't use the term as-builts).

The Scope of Work does say at Item F. that they shall obtain the permits required for Work. Exactly what permits are you talking about here?

Response: Construction permits associated with Rockton Township. Drilling permits from the State of Illinois, and utility clearances.

I recall that in the 30% design submittal there were mass balance calculations for the additional loading to the air stripper and the NPDES discharge. I also note that the NPDES discharge criteria do not include standards for cis or trans-1,2-dce nor vinyl chloride. In Bodines reporting of sampling results there were levels of cis-1,2-DCE up to 900 ppb. Are you sure that NPDES would allow discharge of this high of a level of cis-1,2-DCE? I also note about Bodines groundwater monitoring results that they frequently had elevated detection limits probably due to sample dilution and I doubt that this sampling was done in accordance with the new QAPP. Their tables do not report anything for vinyl chloride either. I also recall an earlier discussion that the NPDES permit would have to be renewed every 3 years or so and I see on the IEPA webpage that if you make changes to your system you may have to get the blessing of the NPDES permitting authority so I question whether or not the mass balance calculations have been presented to the IEPA air and NPDES permitting authorities for their concurrence on our changes. You told me that we already had permits from these two entities but I don't recall ever seeing a copy of those permits. Therefore, in order for me to feel comfortable that the Air and NPDES permitting authorities will be satisfied with our changes, I would like to see a letter to both permitting authorities that contains a copy of the existing permits that you say you have and shows them the changes that we are proposing and asks for their concurrence. I would like for this to be submitted as an appendix to the 100% remedial design.

Response: Based on EEEI's review of the current NPDES permit, there is a discharge limit for total 1,2-DCE of 25 ug/L (monthly average) and 574 ug/L (daily maximum). There is no discharge limit established for vinyl chloride because it has never been detected at the site. Nonetheless, vinyl chloride is included in the list of analytical parameters for effluent. To illustrate, the effluent results for May 2007 from Bodine, using the lower detection limits, is attached.

E & E will communicate with the State Air and NPDES authorities if requested by Illinois EPA.

I see in section 1.2 Previous Studies that it doesn't list the QAPP that E&E got approved and the O&M plan is from Montgomery and Watson dated 1996. Therefore, the O&M plan has got to be updated and it would be ideal if the 100% design had a draft O&M plan within it that was finalized after the construction is completed and you receive the as-built drawings that you have required your contractor to submit as I requested earlier in this letter.

Response: EEEI is developing the draft O&M plan and will submit the draft as part of the 100% design submittal. The O&M plan can not be finalized until the system has been constructed and the shake down period completed because changes in the design and operations will undoubtedly occur during construction and initial start-up.

I want to include at the end of this comment letter the following three paragraphs that were inserted into the RD workplan by your contractor to explain how the overall responsibilities on this project because that is the only place where this explanation of roles and responsibilities is located.

Under the direction of the Illinois EPA, responsibility for design and implementation of the final remedy has been divided between three organizations; the Illinois EPA, E & E , and Bodine Environmental Services, Inc. The Illinois EPA will provide overall supervision of the remedial action project and establish a GMZ for the NPL site and Village of Rockton, and conduct routine residential well sampling and analysis.

E & E will provide pre-design activities to be performed during a Source Area Investigation (SAI), Existing Monitoring Well Evaluation, ISCA Engineering Evaluation, and Pilot Test. E & E will also provide the engineering design process and various deliverables to be submitted during the process for all components of the final remedy, including an O & M Plan for long-term maintenance of the Remedial Action.

Bodine Environmental Services, Inc., another Illinois EPA contractor, will be responsible for long-term groundwater monitoring, construction of any modifications to the existing ISCA pump-and-treat system and O & M of this and any other components of the final remedy. Bodine is currently performing O & M of the groundwater treatment system and quarterly groundwater monitoring pursuant to the Action Memorandum for the Interim Source Control Action and the Removal Action Design Report, both of which are part of the Administrative Record for the site.

I think we should update this roles and responsibilities to include a requirement for all sampling and analysis to be conducted under the new QAPP for the site and for all the data to be submitted to us in the Electronic Data Deliverable format available online at
http://www.epa.gov/region5/superfund/edman/index.html

Response: The roles will be defined in the O&M plan. I would not name companies (i.e., Bodine, E&E), but instead leave it to IEPA consultant/engineer and O & M contractor. The new O & M plan will also identify the requirements of a new QAPP.

Sincerely yours,

Jon Peterson

June 5, 2007

Mr. Eric Runkel
Illinois Environmental Protection Agency
Bureau of Land
1021 North Grand Avenue East
Springfield, Illinois 62794-9276

Re: May 2007, Effluent Sampling Results
Bodine Project No. 118337

2010355004 – Winnebago
Beloit/Beloit Corp. NPL Site
Superfund/Technical

Dear Mr. Runkel:

On behalf of the Illinois Environmental Protection Agency (Illinois EPA), Bureau of Land (BOL), Bodine Environmental Services, Inc. (Bodine) performed the bimonthly effluent sampling for the groundwater pump and treat system associated with the above-referenced facility. Both laboratory analytical reports are enclosed.

Bodine collected effluent samples consistent with the previous sample collection procedures used by the treatment works operator, Mr. Tom Dal Santo on May 14 and 21, 2007. The samples were delivered to PDC Laboratories, Inc. and received by the laboratory the next day for analysis of volatile organic compounds (VOCs) using U.S. EPA Method 624, the equivalent of SW 846 8260B R2.0. The laboratory utilized lower reporting limits. Based upon the enclosed laboratory reports, the treated effluent did not contain detectable concentrations of VOCs.

The data will be submitted with the quarterly report. If you have any questions, please contact the undersigned at (800) 637-2379.

Respectfully submitted,
BODINE ENVIRONMENTAL SERVICES, INC.

Stephen D. Nussbaum, P.E.
Senior Project Manager

Brett J. Marshall
Consulting Services Manager

Enclosures: PDC Laboratories, Inc. Laboratory Reports, May 30 and May 31, 2007

Cf: (all with enclosures)
BOL Manager, Rockford Rgn, 1021 N. Grand Ave. East, Springfield, IL 62794-9276
Tom Dal Santo, P.O. Box 14, South Beloit, IL 61080
Kevin Phillips, Ecology & Environment, 33 N. Dearborn, Suite 501, Chicago, IL 60602

PDC Laboratories, Inc.
P.O. Box 9071 • Peoria, IL 61612-9071
(309) 692-9688 • (800) 752-6651 • FAX (309) 692-9689

Bodine Environmental Services
5350 East Firehouse Road
Decatur, IL 62521

Attn: Mr. Stephen Nussbaum

Date Received: 22-May-07
Date Reported 31-May-07

Sample No: 07053463-1 Collect Date: 21-May-07 9:30

Client Id: PROJ #118337 Site: ES052107 Locator: GRAB

	Result		Units	Date / Time	By
SW-846 8260B R2.0					
1,1,1,2-Tetrachloroethane	<	1	ug/l	29-May-07 19:16	DF
1,1,1-Trichloroethane	<	1	ug/l	29-May-07 19:16	DF
1,1,2,2-Tetrachloroethane	<	1	ug/l	29-May-07 19:16	DF
1,1,2-Trichloroethane	<	2	ug/l	29-May-07 19:16	DF
1,1-Dichloroethane	<	1	ug/l	29-May-07 19:16	DF
1,1-Dichloroethene	<	1	ug/l	29-May-07 19:16	DF
1,2,4-Trichlorobenzene	<	1	ug/l	29-May-07 19:16	DF
1,2,4-Trimethylbenzene	<	1	ug/l	29-May-07 19:16	DF
1,2-Dibromo-3-chloropropane	<	2	ug/l	29-May-07 19:16	DF
1,2-Dichlorobenzene	<	2	ug/l	29-May-07 19:16	DF
1,2-Dichloroethane	<	1	ug/l	29-May-07 19:16	DF
1,2-Dichloropropane	<	1	ug/l	29-May-07 19:16	DF
1,3,5-Trimethylbenzene	<	1	ug/l	29-May-07 19:16	DF
1,3-Dichlorobenzene	<	1	ug/l	29-May-07 19:16	DF
1,4-Dichlorobenzene	<	1	ug/l	29-May-07 19:16	DF
2-Butanone	<	2	ug/l	29-May-07 19:16	DF
2-Chloroethylvinyl Ether	<	2	ug/l	29-May-07 19:16	DF
2-Hexanone	<	1	ug/l	29-May-07 19:16	DF
4-Methyl-2-pentanone	<	2	ug/l	29-May-07 19:16	DF
Acetone	<	2	ug/l	29-May-07 19:16	DF
Acetonitrile	<	20	ug/l	29-May-07 19:16	DF
Acrolein	<	20	ug/l	29-May-07 19:16	DF
Acrylonitrile	<	20	ug/l	29-May-07 19:16	DF
Benzene	<	2	ug/l	29-May-07 19:16	DF
Bromochloromethane	<	2	ug/l	29-May-07 19:16	DF
Bromodichloromethane	<	1	ug/l	29-May-07 19:16	DF
Bromoform	<	1	ug/l	29-May-07 19:16	DF
Bromomethane	<	5	ug/l	29-May-07 19:16	DF
Carbon Disulfide	<	1	ug/l	29-May-07 19:16	DF
Carbon Tetrachloride	<	1	ug/l	29-May-07 19:16	DF
Chlorobenzene	<	1	ug/l	29-May-07 19:16	DF

recycled paper

PDC Laboratories, Inc.
P.O. Box 9071 • Peoria, IL 61612-9071
(309) 692-9688 • (800) 752-6651 • FAX (309) 692-9689

ACCREDITED IN ACCORDANCE WITH nelac

Bodine Environmental Services
5350 East Firehouse Road
Decatur, IL 62521

Attn: Mr. Stephen Nussbaum

Date Received: 22-May-07
Date Reported 31-May-07

Sample No: 07053463-1
Collect Date: 21-May-07 9:30
Client Id: PRCJ #118337
Site: ES052107
Locator: GRAB

	Result		Units	Date / Time	By
SW-846 8260B R2.0					
Chloroethane	<	1	ug/l	29-May-07 19:16	DF
Chloroform	<	1	ug/l	29-May-07 19:16	DF
Chloromethane	<	1	ug/l	29-May-07 19:16	DF
cis-1,2-Dichloroethene	<	1	ug/l	29-May-07 19:16	DF
cis-1,3-Dichloropropene	<	1	ug/l	29-May-07 19:16	DF
Dibromochloromethane	<	1	ug/l	29-May-07 19:16	DF
Dichlorodifluoromethane	<	1	ug/l	29-May-07 19:16	DF
Ethylbenzene	<	1	ug/l	29-May-07 19:16	DF
Ethylene Dibromide	<	1	ug/l	29-May-07 19:16	DF
m,p-Xylene	<	1	ug/l	29-May-07 19:16	DF
Methylene Chloride	<	3	ug/l	29-May-07 19:16	DF
Methyl-tert-Butyl Ether	<	2	ug/l	29-May-07 19:16	DF
n-Butanol	<	100	ug/l	29-May-07 19:16	DF
o-Xylene	<	1	ug/l	29-May-07 19:16	DF
Styrene	<	1	ug/l	29-May-07 19:16	DF
Tetrachloroethene	<	1	ug/l	29-May-07 19:16	DF
Toluene	<	2	ug/l	29-May-07 19:16	DF
trans-1,2-Dichloroethene	<	1	ug/l	29-May-07 19:16	DF
trans-1,3-Dichloropropene	<	1	ug/l	29-May-07 19:16	DF
Trichloroethene	<	1	ug/l	29-May-07 19:16	DF
Trichlorofluoromethane	<	1	ug/l	29-May-07 19:16	DF
Vinyl Acetate	<	1	ug/l	29-May-07 19:16	DF
Vinyl Chloride	<	1	ug/l	29-May-07 19:16	DF
Xylenes (Total)	<	2	ug/l	29-May-07 19:16	DF

PDC Laboratories, Inc.
P.C. Box 9071 • Peoria, IL 61612-9071
(309) 692-9688 • (800) 752-6651 • FAX (309) 692-9688

ACCREDITED IN ACCORDANCE WITH nelac

Bodine Environmental Services
5350 East Firehouse Road
Decatur, IL 62521

Attn: Mr. Stephen Nussbaum

Date Received: 22-May-07
Date Reported 31-May-07

Certified by: Lisa Grant

Lisa Grant, Project Manager

PDC Laboratories participates in the following laboratory accreditation/certification and proficiency programs. Endorsement by the Federal or State Government or their agencies is not implied.

NELAC Accreditation for Drinking Water, Wastewater, Hazardous and Solid Wastes Fields of Testing through IL EPA Lab No. 100230
State of Illinois Bacteriological Analysis in Drinking Water Certified Lab Registry No. 17533
Drinking Water Certifications: Indiana (C-IL-04); Kansas (E-10338); Kentucky (90058); Missouri (00870); Wisconsin (998294430)
Wastewater Certifications: Arkansas; Iowa (240); Kansas (E-10338); Wisconsin (99829443
Hazardous/Solid Waste Certifications: Arkansas; Kansas (E-10338); Wisconsin (998294430)
UST Certification: Iowa (240)

recycled paper

PDC LAL .RATORIES, INC.
2231 WEST ALTORFER DRIVE
PEORIA, IL 61615

PHONE # 309-692-9688
FAX # 309-692-9689

CHAIN OF CUSTODY I. .CORD

State where samples collected ______

ALL HIGHLIGHTED AREAS MUST BE COMPLETED BY CLIENT (PLEASE PRINT) - (SAMPLE ACCEPTANCE POLICY ON REVERSE)

1

CLIENT: Bodine Environmental Services
ADDRESS: 5350 E. Firehouse Rd
Decatur, IL 62521
CITY STATE ZIP: IEPA - Beloit Corp GW Treat
Rockton, IL
CONTACT PERSON: Stephen Nussbaum

PROJECT NUMBER	P.O. NUMBER	MEANS SHIPPED
118337		UPS
PHONE NUMBER	FAX NUMBER	DATE SHIPPED
217 428-3629	217 864-2086	5/21/07

SAMPLER (PLEASE PRINT): Kris Dal Santo
SAMPLER'S SIGNATURE: Kris Dal Santo

MATRIX TYPES:
WW-WASTEWATER
DW-DRINKING WATER
GW-GROUND WATER
WWSL-SLUDGE
NAS-SOLID
LCHT-LEACHATE
OTHER: ______

3 ANALYSIS REQUESTED

4 (FOR LAB USE ONLY)
LOGIN # 07053463-1
LOGGED BY: DTM
LAB PROJ. # ______
TEMPLATE: ______
PROJ. MGR.: ______

2

SAMPLE DESCRIPTION AS YOU WANT ON REPORT	DATE COLLECTED	TIME COLLECTED	SAMPLE TYPE GRAB	SAMPLE TYPE COMP.	MATRIX TYPE	BOTTLE COUNT	VOC's							REMARKS
ES052107	5/21/07	9:30 AM	X		GW	3	X							

5 TURNAROUND TIME REQUESTED (PLEASE CIRCLE) NORMAL RUSH
(RUSH TAT IS SUBJECT TO PDC LABS APPROVAL AND SURCHARGE)
DATE RESULTS NEEDED
RUSH RESULTS VIA (PLEASE CIRCLE) pdf FAX PHONE
FAX # IF DIFFERENT FROM ABOVE: PHONE # IF DIFFERENT FROM ABOVE:

6 *The sample temperature will be measured upon receipt at the lab. By initialing this area you request that the lab notify you, before proceeding with analysis, if the sample temperature is outside of the range of 0.1-6.0°C. By not initialing this area you allow the lab to proceed with analytical testing regardless of the sample temperature.* ______

7

RELINQUISHED BY: (SIGNATURE)	DATE / TIME	RECEIVED BY: (SIGNATURE)	DATE / TIME
Kris Dal Santo	DATE 5/21/07 TIME		DATE TIME
RELINQUISHED BY: (SIGNATURE)	DATE TIME	RECEIVED BY: (SIGNATURE)	DATE TIME
RELINQUISHED BY: (SIGNATURE)	DATE TIME	RECEIVED AT LAB BY: (SIGNATURE) D. Malak	DATE 5-22-07 TIME 8:45

8 COMMENTS: (FOR LAB USE ONLY)

SAMPLE TEMPERATURE UPON RECEIPT 14 °C
CHILL PROCESS STARTED PRIOR TO RECEIPT Y OR N
SAMPLE(S) RECEIVED ON ICE Y OR N
PROPER BOTTLES RECEIVED IN GOOD CONDITION Y OR N
BOTTLES FILLED WITH ADEQUATE VOLUME Y OR N
SAMPLES RECEIVED WITHIN HOLD TIME(S) Y OR N
(EXCLUDES TYPICAL FIELD PARAMETERS)
DATE AND TIME TAKEN FROM SAMPLE BOTTLE ______

)ies: white should accompany samples to PDC Labs. Yellow co be retained by the client.

PDC Laboratories, Inc.
P.O. Box 9071 • Peoria, IL 61612-9071
(309) 692-9688 • (800) 752-6651 • FAX (309) 692-9689

ACCREDITED IN ACCORDANCE WITH nelac

Bodine Environmental Services
5350 East Firehouse Road
Decatur, IL 62521

Attn: Mr. Stephen Nussbaum

Date Received: 15-May-07
Date Reported 30-May-07

Sample No: 07052756-1
Collect Date: 14-May-07 10:15
Client Id: PROJECT #118337
Site: ES050907
Locator: GRAB

	Result		Units	Date / Time	By
SW-846 8260B R2.0					
1,1,1,2-Tetrachloroethane	<	1	ug/l	18-May-07 17:49	DF
1,1,1-Trichloroethane	<	1	ug/l	18-May-07 17:49	DF
1,1,2,2-Tetrachloroethane	<	1	ug/l	18-May-07 17:49	DF
1,1,2-Trichloroethane	<	2	ug/l	18-May-07 17:49	DF
1,1-Dichloroethane	<	1	ug/l	18-May-07 17:49	DF
1,1-Dichloroethene	<	1	ug/l	18-May-07 17:49	DF
1,2,4-Trichlorobenzene	<	1	ug/l	18-May-07 17:49	DF
1,2,4-Trimethylbenzene	<	1	ug/l	18-May-07 17:49	DF
1,2-Dibromo-3-chloropropane	<	2	ug/l	18-May-07 17:49	DF
1,2-Dichlorobenzene	<	2	ug/l	18-May-07 17:49	DF
1,2-Dichloroethane	<	1	ug/l	18-May-07 17:49	DF
1,2-Dichloropropane	<	1	ug/l	18-May-07 17:49	DF
1,3,5-Trimethylbenzene	<	1	ug/l	18-May-07 17:49	DF
1,3-Dichlorobenzene	<	1	ug/l	18-May-07 17:49	DF
1,4-Dichlorobenzene	<	1	ug/l	18-May-07 17:49	DF
2-Butanone	<	2	ug/l	18-May-07 17:49	DF
2-Chloroethylvinyl Ether	<	2	ug/l	18-May-07 17:49	DF
2-Hexanone	<	1	ug/l	18-May-07 17:49	DF
4-Methyl-2-pentanone	<	2	ug/l	18-May-07 17:49	DF
Acetone	<	2	ug/l	18-May-07 17:49	DF
Acetonitrile	<	20	ug/l	18-May-07 17:49	DF
Acrolein	<	20	ug/l	18-May-07 17:49	DF
Acrylonitrile	<	20	ug/l	18-May-07 17:49	DF
Benzene	<	2	ug/l	18-May-07 17:49	DF
Bromochloromethane	<	2	ug/l	18-May-07 17:49	DF
Bromodichloromethane	<	1	ug/l	18-May-07 17:49	DF
Bromoform	<	1	ug/l	18-May-07 17:49	DF
Bromomethane	<	5	ug/l	18-May-07 17:49	DF
Carbon Disulfide	<	1	ug/l	18-May-07 17:49	DF
Carbon Tetrachloride	<	1	ug/l	18-May-07 17:49	DF
Chlorobenzene	<	1	ug/l	18-May-07 17:49	DF

recycled paper

PDC Laboratories, Inc.
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(309) 692-9688 • (800) 752-6651 • FAX (309) 692-9689

ACCREDITED IN ACCORDANCE WITH nelac

Bodine Environmental Services
5350 East Firehouse Road
Decatur, IL 62521

Attn: Mr. Stephen Nussbaum

Date Received: 15-May-07
Date Reported 30-May-07

Sample No: 07052756-1 | Collect Date: 14-May-07 10:15

Client Id: PROJECT #118337 | Site: ES050907 | Locator: GRAB

	Result		Units	Date / Time	By
SW-846 8260B R2.0					
Chloroethane	<	1	ug/l	18-May-07 17:49	DF
Chloroform	<	1	ug/l	18-May-07 17:49	DF
Chloromethane	<	1	ug/l	18-May-07 17:49	DF
cis-1,2-Dichloroethene	<	1	ug/l	18-May-07 17:49	DF
cis-1,3-Dichloropropene	<	1	ug/l	18-May-07 17:49	DF
Dibromochloromethane	<	1	ug/l	18-May-07 17:49	DF
Dichlorodifluoromethane	<	1	ug/l	18-May-07 17:49	DF
Ethylbenzene	<	1	ug/l	18-May-07 17:49	DF
Ethylene Dibromide	<	1	ug/l	18-May-07 17:49	DF
m,p-Xylene	<	1	ug/l	18-May-07 17:49	DF
Methylene Chloride	<	3	ug/l	18-May-07 17:49	DF
Methyl-tert-Butyl Ether	<	2	ug/l	18-May-07 17:49	DF
n-Butanol	<	100	ug/l	18-May-07 17:49	DF
o-Xylene	<	1	ug/l	18-May-07 17:49	DF
Styrene	<	1	ug/l	18-May-07 17:49	DF
Tetrachloroethene	<	1	ug/l	18-May-07 17:49	DF
Toluene	<	2	ug/l	18-May-07 17:49	DF
trans-1,2-Dichloroethene	<	1	ug/l	18-May-07 17:49	DF
trans-1,3-Dichloropropene	<	1	ug/l	18-May-07 17:49	DF
Trichloroethene	<	1	ug/l	18-May-07 17:49	DF
Trichlorofluoromethane	<	1	ug/l	18-May-07 17:49	DF
Vinyl Acetate	<	1	ug/l	18-May-07 17:49	DF
Vinyl Chloride	<	1	ug/l	18-May-07 17:49	DF
Xylenes (Total)	<	2	ug/l	18-May-07 17:49	DF

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Bodine Environmental Services
5350 East Firehouse Road
Decatur, IL 62521

Date Received: 15-May-07
Date Reported 30-May-07

Attn: Mr. Stephen Nussbaum

Certified by:
Lisa Grant, Project Manager

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FAX # 309-692-9689

CHAIN OF CUSTODY CORD

State where samples collected ___________

ALL HIGHLIGHTED AREAS MUST BE COMPLETED BY CLIENT (PLEASE PRINT)

1 CLIENT: Bodine Environmental Services	PROJECT NUMBER: 118337	P.O. NUMBER:	MEANS SHIPPED: UPS
ADDRESS: 5350 E. Firehouse Rd, Decatur, IL 62521	PHONE NUMBER: 217 428-3629	FAX NUMBER: 217 864-2086	DATE SHIPPED: 5/14/07
CITY STATE ZIP: IEPA Beloit Corp GW Treat, Rockton, IL	SAMPLER (PLEASE PRINT): Kris DalSanto		MATRIX TYPES: WW-WASTEWATER, DW-DRINKING WATER, GW-GROUND WATER, WWSL-SLUDGE, NAS-SOLID, LCHT-LEACHATE, OTHER: ____
CONTACT PERSON: Stephen Nussbaum	SAMPLER'S SIGNATURE: Kris DalSanto		

3 ANALYSIS REQUESTED

4 (FOR LAB USE ONLY)
LOGIN 070527561
LOGGED BY: [illegible]
LAB PROJ. #: ____
TEMPLATE: ____
PROJ. MGR.: ____

2 SAMPLE DESCRIPTION AS YOU WANT ON REPORT	DATE COLLECTED	TIME COLLECTED	SAMPLE TYPE: GRAB	SAMPLE TYPE: COMP	MATRIX TYPE	BOTTLE COUNT	VOCs							REMARKS
ES050907	5/14/07	10:15	X		GW	3	X							

5 TURNAROUND TIME REQUESTED (PLEASE CIRCLE) NORMAL RUSH
(RUSH TAT IS SUBJECT TO PDC LABS APPROVAL AND SURCHARGE)
DATE RESULTS NEEDED ____
RUSH RESULTS VIA (PLEASE CIRCLE) pdf FAX PHONE
FAX # IF DIFFERENT FROM ABOVE: ____ PHONE # IF DIFFERENT FROM ABOVE: ____

6 *The sample temperature will be measured upon receipt at the lab. By initialing this area you request that the lab notify you, before proceeding with analysis, if the sample temperature is outside of the range of 0.1-6.0°C. By not initialing this area you allow the lab to proceed with analytical testing regardless of the sample temperature.* ____

7 RELINQUISHED BY: (SIGNATURE)	DATE / TIME	RECEIVED BY: (SIGNATURE)	DATE / TIME
Kris DalSanto	DATE 5/14/07 TIME 12:35		DATE TIME
RELINQUISHED BY: (SIGNATURE)	DATE TIME	RECEIVED BY: (SIGNATURE)	DATE TIME
RELINQUISHED BY: (SIGNATURE)	DATE TIME	RECEIVED AT LAB BY: (SIGNATURE) [signature]	DATE 5/15/07 TIME 8:15

8 COMMENTS: (FOR LAB USE ONLY)
SAMPLE TEMPERATURE UPON RECEIPT 1.7 °C
CHILL PROCESS STARTED PRIOR TO RECEIPT Y OR N
SAMPLE(S) RECEIVED ON ICE Y OR N
PROPER BOTTLES RECEIVED IN GOOD CONDITION Y OR N
BOTTLES FILLED WITH ADEQUATE VOLUME Y OR N
SAMPLES RECEIVED WITHIN HOLD TIME(S) Y OR N
(EXCLUDES TYPICAL FIELD PARAMETERS)
DATE AND TIME TAKEN FROM SAMPLE BOTTLE ____

Copies: white should accompany samples to PDC Labs. Yellow c o be retained by the client.

B

B

Effluent Discharge Pipe and Transfer Pump Calculations

Memorandum

ecology & environment engineering, inc.
International Specialists in the Environment

Date: April 12, 2007

To: Beloit Corporation 30% Design Report

Prepared by: Tom Campbell, P.E.

Checked by: Neil Brown, P.E.

Subject: Discharge Pipe and Transfer Pump Sizing

Objective

The objective of this technical memorandum is to verify that the size of the existing effluent discharge line is sufficient to support the increase in flow associated with the addition of three new groundwater extraction wells. Additionally, the size of the existing transfer pump was evaluated to ensure that it has the necessary capacity.

Background

The current remedy at the Beloit Corporation site includes four groundwater extraction wells operating with five pumps. It has been proposed that three additional extraction wells be added to the existing system to address the source area portion of the groundwater contaminant plume. The existing groundwater extraction system focuses on the edge of the plume by using the existing down gradient extraction wells. The extracted groundwater is treated via air stripping and discharged under a National Pollutant Discharge Elimination System (NPDES) permit to the Rock River via the effluent discharge line.

Discussion

Determining Gravity Flow through the Pipe

When possible, pipe diameter would be sized in accordance with the calculations outlined in the following section (*Determining Pipe Size*). However, the effluent pipe is already in place and the following calculations were performed to ensure that the existing pipe is of sufficient diameter to handle the volume of effluent. Using Manning's flow equation, the pipe was first checked to see if it could drain relying on just gravity flow.

$$V = \frac{1.486 \cdot R^{0.667} \cdot S^{0.5}}{n} \quad \text{(Equation 1)}$$

Where V is the average flow velocity, R is the hydraulic radius in feet, and S is the pipe slope expressed in feet per foot. Manning's flow coefficient, n, is 0.010 for plastic pipe. The hydraulic radius is equal to the fullness factor multiplied by the pipe inside diameter in feet. Once the velocity is obtained the flow rate can be calculated with the equation:

$$Q = 449 \cdot V \cdot A \cdot d^2 \quad \text{(Equation 2)}$$

A is the area factor obtained from the fullness factor table.

The effluent pipe is constructed of approximately 1,900 feet of Schedule 40 polyvinyl chloride (PVC) pipe. With a pump elevation of 755 ft MSL and a surface water elevation on the Rock River of 730 ft MSL, the elevation change would be approximately 25 feet. Assuming gravity flow from the treatment building with only pipe friction losses, i.e., no losses due to pipe bends, the effluent pipe is capable of draining at a flow rate of 380 gallons per minute (gpm) with a velocity of 4.27 ft/sec. These calculations are summarized in the attached worksheets.

Given that the existing air stripper has a treatment capacity of 400 gpm, almost the full capacity of the air stripper discharge could be gravity drained provided the effluent line was a straight run of pipe. However, a pump was installed and is used to overcome frictional losses associated pipe bends and fittings.

In order to size the transfer pump, additional calculations were performed. In order to be conservative, a flow rate of 410 gpm (110% of the air stripper capacity) was used. Additionally, it was assumed that nine 90-degree elbows and eight 45-degree elbows were components of the effluent pipeline. Based on the calculations and with an added safety factor of 2, the design head of the pump must be greater than 107 feet and have a design horsepower of equal to or greater than 14. The existing transfer pump has a 15-HP motor capable of pumping at a discharge rate of 450 gpm. It was also determined that at a maximum pump flow rate of 450 gpm, the pump would exert a pressure of 90 psi on the effluent piping. Six-inch Schedule 40 PVC pipe is rated for a working pressure of 180 psi in compliance with both ASTM D1785 (pressure pipe) and ASTM D2665 (drain, waste & vent pipe)..

These numbers were arrived at in the following manner.

Determining Pipe Size

The calculation used to determine pipe size is the continuity equation: $Q = A \cdot V$ (Equation 3)

Where Q equals volumetric flow rate, A is the area of the pipe based on internal diameter, and V is the velocity of the water (Munson 1990). Flow rate is known from the manufacturer's pump data or design calculations, and the inner diameter of the piping material can be obtained from plastic pipe manufacturers' literature (Indelco 2003, Plastic Pipe Institute 2000, Harvel Plastics 2005, ISCO 2005). Piping diameter should be selected so that the velocity is greater than 4 feet per second (Ten State Standards 1990) and less than 10 feet per second (Plastic Pipe Institute 2000). A standard target is 7 feet per second (USACE 1999). If solids are present in the flow then a velocity of less than 4 feet per second should be avoided to prevent solids from settling on the bottom of the pipe and hindering flow.

Data supplied by the pump manufacturer. show that the transfer pump discharge port has a maximum flow rate of 450 gpm. The six inch schedule 40 pipe has an inner diameter of 6.031 inches. The velocity through the pipe has been calculated to be approximately 5 feet per second at maximum flow. In order to get a velocity above 7 feet per second. the pipe diameter would need to be 5 inches in diameter which is a nonstandard size.

Determining Head Loss

The calculation used to determine head loss is Bernoulli's equation which is made up of velocity head. pressure head. elevation head. and head losses:

$$\frac{V_1^2}{2g} + \frac{P_1}{\rho} + Z_1 = \frac{V_2^2}{2g} + \frac{P_2}{\rho} + Z_2 + h_L \qquad \text{(Equation 4)}$$

Where V is velocity, g is the acceleration due to gravity. P is pressure, ρ is the density of water, Z is elevation. and h_L is head loss (Hwang 1987). Head losses are made up of friction losses and losses due to constrictions. expansions. fittings. joints. and pipe bends. For our scenario, the change in velocity over any section of pipe is negligible so the equation becomes:

$$\frac{P_1}{\rho} - \frac{P_2}{\rho} = (Z_2 - Z_1) + h_L \qquad \text{(Equation 5)}$$

The change in pressure head is equal to the change in elevation head plus head losses. The change in elevation head may be positive or negative depending on whether the piping is running uphill or downhill. The change in elevation for the piping system was determined from a topographic map of the site. As stated previously. the elevation change from the ISCA pump-and-treat building to the Rock River is approximately 25 feet.

The calculation used to determine head loss due to friction was the Darcy-Weisbach formula:

$$h_f = \frac{f \cdot L \cdot V^2}{2 \cdot D \cdot g} \qquad \text{(Equation 6)}$$

Where f is the Moody friction factor. L is the length of pipe. V is the velocity of water in the pipe. D is the pipe inner diameter. and g is the acceleration due to gravity (Hwang 1987). The above equation may be used for any fully-developed, steady. incompressible pipe flow.

The Moody friction factor was determined by the equation:

$$f = \frac{1.325}{[\ln(\frac{e}{3.7D} + \frac{5.74}{\mathrm{Re}^{0.9}})]^2} \quad \text{where } \mathrm{Re} = \frac{D \cdot V}{\nu} \qquad \text{(Equation 7)}$$

The symbol e is the specific roughness of the pipe material, Re is the Reynolds number, and v is the kinematic viscosity of water. The specific roughness was modeled at 0.01 (PPI 2005) and the kinematic viscosity for water at 50 degrees Fahrenheit, 1.41×10^{-5} ft^2/sec, was used.

The calculated head loss, h_f, gives the loss per 100 feet of piping. Head losses due to pipe fittings were modeled using equivalent lengths. The actual length of pipe along with the equivalent length of pipe were summed and divided by 100 to give the total length of pipe to be multiplied by the head loss, h_f, as calculated using the Darcy-Weisbach formula.

Since the transfer pump has water gravity fed by piping directly into the pump there is no suction head. A pipe that has to "pull" water up from a lower elevation would have a suction head associated with it. There is also no drawdown to consider as there would be with an extraction well pump since the water entering the pump can be considered to always be at the same elevation. However, elevation head from the site topography does play a factor as was discussed in the gravity flow calculations above. An elevation head of -25 feet is present. A total head, h_T, is calculated by adding together all friction head and elevation head values. These calculations are summarized in the attached worksheets.

Determining Pump Motor Size

The pump motor currently installed at the P&T building is 15 horsepower (Hp). Based on spreadsheet calculations, a 14 HP motor is needed to pump water to the outfall location at 450 gallons per minute. The equation used to determine required horsepower is:

$$HP = \frac{Q \cdot SG_{H_2O} \cdot H_T}{3956 \cdot Efficiency} \quad \text{(Equation 8)}$$

The specific gravity of water is 1.0, and the efficiency used was 85 percent.

Determining Pipe Pressure Rating

Pressure in the pipe was calculated using the following equation:

$$P = \frac{\rho \cdot (\text{Pump head} + \text{elevation head} + \text{head loss})}{144} \quad \text{(Equation 9)}$$

The pump head is determined by taking Equation 8 and solving for H_T. This gives the exact head supplied by the selected pump, which usually does not supply exactly the same HP as the design HP. The same friction head and elevation head values calculated for the piping network are used. The values are all summed and multiplied by the density of water to determine the pressure within the pipe. Pressure in the pipe was calculated as 90 pounds per square inch (psi) with an added safety factor of 25%. These calculations are summarized in the attached worksheet.

Conclusion

The effluent discharge piping and pump motor is sized correctly for discharge to the Rock River. Schedule 40, 6-inch PVC pipe is pressure rated for a maximum internal working pressure of 180 psi (Harvel Plastics 2007).

References

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Worksheet for determining Gravity Flow conditions through the Beloit Effluent Pipe

Pipe consists of a 6-inch Schedule 40 Polyvinyl Chloride (PVC) pipe.

Known

Inner Diameter (d) =	6.031 inches
Length =	1,900 feet
Elevation change to MH =	25 feet

Calculated

Slope (S) =	0.013158 ft/ft

V = 4.273107 ft/sec

Q = 380.6249 gpm

Equations

Gravity Flow through Pipes

$$V = \frac{1.486 \bullet R^{0.667} \bullet S^{0.5}}{n}$$

$$R = f \bullet d$$

V = Average flow velocity, ft/sec
R = hydraulic radius, feet
S = Slope of pipe, feet per foot
n = Manning's flow coefficient, 0.010
f = Fullness factor from table
d = Inside diameter, feet

$$Q = 449 \bullet V \bullet A \bullet d^2$$

Q = volumetric flow rate, gpm
A = Area factor from fullness factor table

Fullness Factors

h/d	f	A
0.05	0.0326	0.0147
0.10	0.0636	0.0409
0.15	0.0929	0.0739
0.20	0.1206	0.1118
0.25	0.1466	0.1535
0.30	0.1710	0.1982
0.35	0.1935	0.2450
0.04	0.2143	0.2934
0.45	0.2331	0.3428
0.50	0.2500	0.3927
0.55	0.2649	0.4426
0.60	0.2776	0.4920
0.65	0.2881	0.5404
0.70	0.2962	0.5872
0.75	0.3017	0.6319
0.80	0.3042	0.6736
0.85	0.3033	0.7115
0.90	0.2980	0.7445
0.95	0.2864	0.7707
1.00	0.2500	0.7854

Beloit Corporation: Calculations for Transfer Pump Motor Sizing

Constants, Variables, and Assumptions

ρ =	62.428	lbm/ft^3
ν @ 50°F =	1.41E-05	ft^2/sec
e =	0.01	ft
g =	32.174	ft/sec^2
SG of water=	1	
π =	3.1415927	

ρ = density
v = kinematic viscosity
e = specific roughness
g = gravity
SG = specific gravity
π = pi
Re=Reynold's Number
f = Moody Friction Factor

gpm=gallons per minute
Q=Maximum Flow Rate
ID=Inner Pipe Diameter
A=Inner Cross Sectional Area of Pipe
V=Fluid Velocity
bgs=below ground surface
hf=Energy loss due to friction
L=100 feet of pipe
L_p=Actual Length of Pipe
L_e=Equivilant Length of Pipe Fittings
h1=Head Loss Due to Pipe Friction

Assumptions
T = 50°F
Turbulent Flow

Table 1: Calculations for Flow through Effluent Pipe and Transfer Pump Sizing

Well Number or Location	Flow	Flow	Pipe Description	Inside Diameter of Pipe	Inside area of Pipe	velocity	Reynolds Number	Moody friction factor	Energy loss from friction in 100 feet of pipe	Length of Pipe	Equivalent length of fittings
Units	GPM	ft^3/sec		feet	$feet^2$	feet/sec	unit less	unit less	feet	feet	feet
Equation	Q	Q		ID	A=π*(ID/2)^2	V=Q/A	Re=ID*V/v	f=1.325/[ln(e/3.7ID+5.74/Re^0.9)]^2	hf=(f*L*V^2)/(2*ID*g)	L_p	L_e
Effluent Pipe	440	0.98032	6 inch schedule 40 PVC	0.503	0.198	4.94153426	1.761E+05	0.0489	3.69	1900	226

Well Number or Location	Head Loss due to friction in pipe	Suction	Static Water Level in well	Drawdown	Pumping Water Level	Elevation Gain	Total Head	Safety Factor Added	Design Head	Horsepower required for pump	Design Horsepower
Units	feet	feet bgs	feet bgs	feet	feet bgs	feet	feet	feet	feet	HP	Horsepower
Equation	h_1			D_n	h_2	h_3	h_T = h1 + h2 + h3+FM ht+FM ht	2.00		HP=(h_T*Q [in GPM] * SG / 3956) / 85%	
Effluent Pipe	78.50	0	0	0	0	-25	53.50	106.99	107	14.00	15.00

Table 2: Equivalent Length Calculations for Effluent Pipe

Fitting Type	Effluent Line (6-inch PVC)	No.	Equivalent Length (feet)
90 degree elbow	18.0	9	162.00
45 degree elbow	8.0	8	64.00

Fittings (equivalent lengths for each fitting were approximated using thermoplastic piping tables provided by Harrington Industrial Plastics, Inc. January 1990 Engineering Handbook)

Calculated Pressure, P_T, Exerted within Effluent Piping

Equation 1: Total Head

$$h_T = \frac{HP \times 3956 \times Eff}{Q \times SG_{H_20}}$$

Calculated head for 15-HP pump at 450 gpm (EQ. 1) = 112.09 feet

Using:

Horsepower (HP) = 15
Efficiency (Eff)= 85 %
Flowrate (Q) = 450 gpm
Specific Gravity of H20 (SG) = 1.0

Equation 2: Friction, Darcy-Weisbach Formula

$$h_f = \frac{f \cdot L \cdot v^2}{2 \cdot D \cdot g}$$

Calculated friction within the effluent piping (EQ. 2) = 78 feet

Using:

Friction Loss calculated in Table 1 using Equation 2.

Table 3: Pressure Exerted within Effluent Piping

Location	Elevation	Elevation	delta z	Total Head	H_f	delta P	P_T	FS = 1.25
	z1	z2	Z (ft)	ft	ft	psi	psi	psi
Effluent Pipe	755	730	-25	112	78	72	72	90

6-inch Schedule 40 PVC pipe maximum working pressure*= 180 psi

*Harvel Plastics, Inc. (2007) accessed on the Web at http://www.harvel.com/tech-specs-pvc-pipe-40.asp

C

Mass Balance Calculations for Expansion of Existing Ground-water Extraction and Treatment System

International Specialists in the Environment

TECHNICAL MEMORANDUM

Date: April 12, 2007
Revised: October 17, 2007

To: Project File

Prepared by: Neil J. Brown, P.E.

Checked By: Tom Campbell, P.E.

Subject: Mass Balance Calculations for Expansion of Existing Groundwater Extraction and Treatment System – Former Beloit Corporation (Blackhawk Facility) Rockton, Illinois

The purpose of this Technical Memorandum (TM) is to present the calculations and data associated with the justification that the existing groundwater treatment plant at the above-referenced site is capable of meeting its National Pollutant Discharge Elimination System (NPDES) permit requirements once three new groundwater extraction wells are constructed and placed into operation. Additionally, air discharge calculations associated with an increase in atmospheric loadings were also performed.

Background

The former Beloit Corporation's Blackhawk facility (the site) is located in Rockton Township in north-central Illinois. This National Priorities List (NPL) site occupies part of the northern half of Section 13 and the southwest quadrant of Section 12, T46N, R1E, Winnebago County, Illinois.

The final Record of Decision (ROD) for the site was signed September 2004. The selected remedial action contained in the ROD is a final, sitewide remedy that addresses the groundwater and soil contamination at the site. The ROD specifies that the primary remedy for the site is the existing pump-and-treat system, which is to be augmented by chemical oxidation of groundwater and soil in the Erection Bay source area, and the installation of additional extraction wells, as necessary.

Based on the findings of a Source Area Investigation (SAI) performed by Ecology and Environment, Inc. (E & E), it was determined that the source area is approximately five times larger than the source area delineated in the Remedial Investigation and evaluated in the Feasibility Study report. (The SAI defined *source areas* as areas where groundwater total volatile organic compound (VOC) concentrations are approximately 500 micrograms per liter [µg/L] or more.)

Based on the findings of the SAI, the Illinois Environmental Protection Agency (Illinois EPA) subsequently tasked Ecology and Environment Engineering, Inc. (EEEI) to develop plans and specifications for expanding the existing pump-and-treat system by installing three new ground-water extraction wells.

Mass Balance Calculations

The current pump-and-treat system relies on an air stripper to remove VOCs from the aqueous influent stream. The stripped VOCs are subsequently discharged to the atmosphere. The air stripper is rated to handle an influent stream of 400 gallons per minute (gpm). Currently, groundwater is extracted and processed through the system at a rate of 170 gpm. In theory, the existing system has the capacity for expansion.

In order to determine whether the existing pump-and-treat system has the capacity to effectively remove the additional loading associated with the three new extraction wells, it is necessary to perform mass balance calculations. The NPDES permit (Permit #IL0064564) for the site has established 30-day average and maximum daily discharge criteria for the following chlorinated VOCs:

- 1,1,1–Trichloroethane (22 µg/L monthly average and 59 µg/L daily maximum);
- 1,1-Dichloroethene (22 µg/L monthly average and 59 µg/L daily maximum);
- 1,2–Dichloroethane (25 µg/L monthly average and 66 daily µg/L maximum);
- Tetrachloroethene (52 µg/L monthly average and 164 µg/L daily maximum);
- Trichloroethene (26 µg/L monthly average and 69 µg/L daily maximum);
- 1,1-Dichloroethene (22 µg/L monthly average and 59 µg/L daily maximum); and
- Total 1,2–Dichloroethene (180 µg/L monthly average and 574 µg/L daily maximum).

For total 1,2-dichloroethene, the analytical results provided to EEEI presents data as cis 1,2-dichloroethene and trans 1,2-dichloroethene. Mass balance calculations have been performed for both cis and trans and these individual values were then subsequently added together to obtain information for total 1,2-dichloroethene.

Once the contaminants have been selected, it is necessary to determine the removal efficiency of *the existing system with regard to each contaminant. Influent and effluent data for the treatment* system was used (influent and effluent data is presented as Attachments 1 and 2, Tables B1 and B2. It should be noted that concentrations for much of the influent and effluent data were reported as not detected, and the detection limit was stated (e.g., < 5 µg/L). In these instances and to be conservative, a value of one-half the detection limit was used in the calculations. Where one-half the detection limit was used, the concentrations are italicized in Tables B1 and B2. Additionally, there was a total of only 6 influent samples (EWC-extraction wells combined collected and analyzed over the course of three years of operation.

Using the data from 2004, 2005, and 2006, the yearly average, maximum, and minimum concentrations for each contaminant were determined (see Tables 1 and 2). Using the average influent and effluent concentrations for a contaminant, the pump-and-treat removal efficiency was calculated using the following equation:

Removal Efficiency = 100 x (C_{inf} – C_{eff})/C_{inf} Where: C_{inf} = Influent Concentration
C_{eff} = Effluent Concentration

This calculation was performed on a yearly basis for each contaminant. A summary of the results is presented in Table 3. While flow is a major component of this calculation, it was not incorporated in this set of calculations. Based on operational data for the treatment system, influent and effluent flow rates were consistently reported at 170 gpm. Given this steady-state condition, flow data was not needed.

It should be noted that for 1,1-dichloroethane, 1,2-dichloroethane, and trans 1,2-dichloroethene, analytical results for all influent and effluent samples were non-detect. If removal efficiencies were to be calculated for these compounds, the value would be based solely on method detection limits. Therefore, their removal efficiencies were not calculated. Additionally, the data for 2006 also did not detect cis 1,2-dichloroethene, 1,1,1-trichloroethene, or 1,1-dichloroethene in the either the influent or effluent data, so no removal efficiencies were calculated. Similarly, a removal efficiency for 1,1-dichloroethene was not calculated for the 2004 year of operation.

In order to determine whether the existing treatment system has sufficient capacity, it is necessary to determine the increase in flow and the contaminant concentration associated with it. As part of the 30% remedial design effort, EEEI used FLOWPATH II (Version 1.1), developed by Waterloo Hydrogeologic Inc., to model the source area. Based on the model results, it was determined that three additional groundwater extraction wells (EW05, EW06, and EW07) are needed to address source area contamination. Target pumping rates for the additional extraction wells are as follows:

- EW05 – 14 gpm;
- EW06 – 14 gpm; and
- EW07 – 14 gpm.

Using data from the SAI, the contaminant concentration for each new extraction well was estimated. Table 4 provides a summary of the influent concentrations for each new extraction well, as well as the sampling location source that was used to predict the influent concentration.

Once the existing removal efficiencies, and new influent flow and associated contaminant concentrations were developed, mass balance calculations were performed.

The mass balance calculations include a series of individual calculations whereby the mass of an individual contaminant for an individual stream is determined. By summing the individual mass values and the total flow (existing flow plus new flow), a total mass load as well as a new influent concentration is determined. The new resulting effluent concentration is calculated as follows:

$C_{eff} = 1 - (\text{Removal Efficiency} \times C_{inf})$ Where: C_{inf} = Influent Concentration
C_{eff} = Effluent Concentration

Two sets of mass balance calculations for each contaminant were performed. Given that the initial mass loading (i.e., the current system operation) varies, this variation can cause changes in the effluent concentration. Therefore, in order to be conservative, for the first set of calculations, the maximum detected influent contaminant concentration and the lowest calculated yearly removal efficiency was used. The second set of calculations use the average influent concentration for the contaminants and the lowest calculated removal efficiency.

For those contaminants (1,1-dichloroethane, 1,2-dichloroethane, trans 1,2-dichloroethene) that did not have a removal efficiency determined or which had limited data (1,1-dichloroethene and cis 1,2-dichoroethene), the average VOC removal efficiency was used.

Table 5 provides a summary of the individual influent and effluent calculations. The NPDES permit limits are also provided in the table. Appendix 3 provides the mass balance calculations (maximum and average) for each individual contaminant.

The results show that the existing pump-and-treat system has the capacity to accept the increase in flow and contaminant loading associated with the installation of the three new groundwater extraction wells.

In addition to performing mass balance calculations associated with aqueous effluent discharge, potential air discharge calculations were also performed. In developing a worst-case scenario, it was assumed that all of the contaminants would be stripped from the influent and discharged to the atmosphere. Under this assumption, it was determined that approximately 503 pounds (i.e., 0.251 tons) of VOCs would be discharged on a yearly basis. Table 6 provides a summary of the worst-case air discharge.

Conclusion

Based on the mass balance calculations performed, the existing pump-and-treat system at the Beloit site has the capacity to accept an increase in flow of approximately 42 gpm, as well as to keep meeting the existing NPDES permit limits associated with chlorinated VOCs, provided the system is properly maintained and operated.

Table 1 Statistical Summary of Influent (EWC) Data
Former Beloit Corporation -Blackhawk Facility
Rockton, Illinois

Concentration	Chemical of Concern								
	1,1-DCA	1,2-DCA	1,1-DCE	cis 1,2-DCE	trans 1,2-DCE	PCE	1,1,1-TCA	TCE	Total VOCS
2004 (3 Sampling Rounds)									
Average	ND	ND	ND	1.26	ND	10.16	1.51	2.31	16.08
Maximum	ND	ND	ND	2.54	ND	18.40	2.79	5.33	30.06
Minimum	ND	ND	ND	0.25	ND	2.20	0.75	0.59	4.29
2005 (2 Sampling Rounds)									
Average	ND	ND	0.70	0.78	ND	12.00	2.20	1.90	18.20
Maximum	ND	ND	1.00	1.00	ND	23.00	3.40	2.80	30.39
Minimum	ND	ND	0.39	0.55	ND	1.00	1.00	1.00	6.00
2006 (1 Sampling Round)									
Average	ND	ND	ND	ND	ND	130.00	ND	2.50	142.50
Maximum	ND	ND	ND	ND	ND	130.00	ND	2.50	142.50
Minimum	ND	ND	ND	ND	ND	130.00	ND	2.50	142.50
Totals for 2004 through 2006 (6 Sampling Rounds)									
Average	ND	ND	0.70	1.02	ND	50.72	1.86	2.24	58.92
Maximum	ND	ND	1.00	2.54	ND	130.00	3.40	5.33	147.50
Minimum	ND	ND	0.39	0.25	ND	1.00	0.75	0.59	5.30

Note: All concentrations are in micrograms per liter.

Table 2 Statistical Summary of Effluent Data
Former Beloit Corporation -Blackhawk Facility
Rockton, Illinois

Concentration	Chemical of Concern								
	1,1-DCA	1,2-DCA	1,1-DCE	cis 1,2-DCE	trans 1,2-DCE	PCE	1,1,1-TCA	TCE	Total VOCS
2004									
Average	ND	ND	ND	0.31	ND	0.90	0.28	0.22	2.96
Maximum	ND	ND	ND	1.00	ND	2.10	1.00	1.00	8.00
Minimum	ND	ND	ND	0.25	ND	0.25	0.10	0.10	1.85
2005									
Average	ND	ND	0.25	0.25	ND	0.68	0.25	0.10	2.26
Maximum	ND	ND	0.25	0.25	ND	0.96	0.25	0.10	2.56
Minimum	ND	ND	0.25	0.25	ND	0.25	0.25	0.10	1.85
2006									
Average	ND	ND	ND	ND	ND	0.76	ND	0.50	4.26
Maximum	ND	ND	ND	ND	ND	1.20	ND	0.50	4.70
Minimum	ND	ND	ND	ND	ND	0.50	ND	0.50	4.00
Totals for 2004 through 2006									
Average	ND	ND	0.25	0.28	ND	0.78	0.27	0.27	3.16
Maximum	ND	ND	0.25	1.00	ND	2.50	1.00	2.50	20.00
Minimum	ND	ND	0.25	0.25	ND	0.25	0.10	0.10	1.90

Note: All concentrations are in micrograms per liter.

Table 3 Summary of Removal Efficiencies
Former Beloit Corporation -Blackhawk Facility
Rockton, Illinois

Year	Chemical of Concern								
	1,1-DCA	1,2-DCA	1,1-DCE	cis 1,2-DCE	trans 1,2-DCE	PCE	1,1,1-TCA	TCE	Total VOCS
2004	NC	NC	NC	75.3%	NC	91.1%	81.2%	90.6%	81.6%
2005	NC	NC	64.0%	67.7%	NC	94.3%	88.6%	94.7%	87.6%
2006	NC	NC	NC	NC	NC	99.4%	NC	80.0%	97.0%
								Three Year Average:	**88.7%**

Key

ND = Not Detected.
1,1-DCA = 1,1-Dichloroethane.
1,2-DCA = 1,2-Dichloroethane.
1,1-DCE = 1,1-Dichloroethene.
cis 1,2-DCE = cis 1,2-Dichloroethene.
trans 1,2-DCE = *trans* 1,2-Dichloroethene.
PCE = Tetrachloroethene.
1,1,1-TCA = 1,1,1-Trichloroethane.
TCE = Trichloroethene.
VOCs = Volatile Organic Compounds.
NC = Not Calculated.

Table 4 Summary of Influent Concentration Data for New Extraction Wells
Former Beloit Corporation -Blackhawk Facility
Rockton, Illinois

Monitoring Well Chemical/New Extraction Well	MW23B EW05	GW07 EW06	GW08 EW07
1,1,1-Trichloroethane	*5*	10	11
1,1-Dichloroethane	*5*	1.6	*1*
1,2-Dichloroethane	*5*	*0.5*	*1*
Tetrachloroethene	1,600	2300	880
Trichloroethene	52	58	5.2
1,1-Dichloroethene	*5*	2	*1*
cis 1,2-dichloroethene	1200	270	8.9
trans 1,2-dichloroethene	23	4.6	0.1

Note: All concentrations are in micrograms per liter, and italic values are one half the method detection limit.

Table 5 **Summary Existing and Future Influent and Effluent Concentrations**
Former Beloit Corporation -Blackhawk Facility
Rockton, Illinois

Chemical	Influent				Effluent				NPDES Limits	
	Existing		Future		Existing		Future		30-Day	Daily
	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum
1,1,1-Trichloroethane	1.9	3.4	3.3	110.5	0.3	1.0	0.6	0.8	22	59
1,1-Dichloroethane	ND	ND	0.6	0.6	ND	ND	0.1	0.1	22	59
1,2-Dichloroethane	ND	ND	0.5	0.5	ND	ND	0.1	0.1	180	574
Tetrachloroethene	50.7	130.0	380.1	442.5	0.8	2.5	33.7	39.2	52	164
Trichloroethene	2.2	5.3	10.0	12.5	0.3	2.5	2.0	2.5	26	69
1,1-Dichloroethene	0.7	1.0	1.1	1.4	0.3	0.3	0.1	0.2	22	60
cis 1,2-dichloroethene	1.0	2.5	109.3	110.5	0.3	1.0	12.3	12.5	NE	NE
trans 1,2-dichloroethene	ND	ND	2.0	2.0	ND	ND	0.2	0.2	NE	NE
total 1,2-dichloroethene	1.0	2.5	111.4	112.6	0.3	1.0	12.6	12.7	25	66

Note: *All concentrations are in micrograms per liter.*

KEY

NPDES = National Discharge Permit Eliminate System.

ND = Not Detected.

NE = Not established.

Table 6 Summary of Air Discharge (Worse Case Scenario)
Former Beloit Corporation -Blackhawk Facility
Rockton, Illinois

Chemical	µg/day	lbs/day	lbs/year	tons/year
1,1,1-Trichloroethane	5,292,944	0.01	4.27	0.002
1,1-Dichloroethane	648,598	0.00	0.52	0.000
1,2-Dichloroethane	558,666	0.00	0.45	0.000
Tetrachloroethene	519.574,520	1.14	419	0.209
Trichloroethene	14,624,180	0.03	11.79	0.006
1,1-Dichloroethene	1,604,840	0.00	1.29	0.001
cis 1,2-dichloroethene	129,795,220	0.29	104.64	0.052
trans 1,2-dichloroethene	2,390,000	0.01	1.93	0.001
Total VOCs:	674,488,968	1.49	544	0.272

KEY

µg/day = Micrograms per day.
lbs/day = Pounds per day.
lbs/year = Pounds per year.
VOCs = Volatile Organic Compounds.

Attachment 1

Influent Data

Table B1 Summary of Influent (EWC) Data
Former Beloit Corporation -Blackhawk Facility
Rockton, Illinois

Sample Date	1,1-DCA	1,2-DCA	1,1-DCE	cis 1,2-DCE	trans 1,2-DCE	PCE	1,1,1-TCA	TCE	Total VOCS
4/14/2004	*1*	*1*	*1*	*1*	*1*	9.88	*1*	*1*	17
10/12/2004	*0.5*	*0.25*	*0.25*	*0.25*	*0.5*	2.2	*0.75*	0.59	5
12/1/2004	*1*	*1*	*1*	2.54	*1*	18.4	2.79	5.33	33
2/24/2005	*1*	*1*	*1*	*1*	*1*	1	*1*	*1*	8
5/12/2005	0.69	*0.025*	0.39	0.55	*0.25*	23	3.4	2.8	31
10/7/2005	not sampled	not sampled	not sampled	not sampled	not sampled	not sampled	not sampled	not sampled	not sampled
5/17/2006	not sampled	not sampled	not sampled	not sampled	not sampled	not sampled	not sampled	not sampled	not sampled
9/28/2006	*2.5*	*2.5*	*2.5*	*2.5*	*2.5*	130	*2.5*	2.5	148
1/10/2007	*0.5*	*0.5*	*0.5*	0.5	*0.5*	17	2	*2*	24

Note: *All concentrations are in micrograms per liter, and values listed in italics were not detected, and one half the detection limit was used.*

Attachment 2

Effluent Data

Table B2 Summary of Effluent Data
Former Beloit Corporation -Blackhawk Facility
Rockton, Illinois

Sample Date	1,1-DCA	1,2-DCA	1,1-DCE	cis 1,2-DCE	trans 1,2-DCE	PCE	1,1,1-TCA	TCE	Total VOCS
11/5/2003	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	1.6	*0.25*	*0.1*	3.2
11/19/2003	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	1.3	*0.25*	*0.1*	2.9
12/3/2003	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	1.4	*0.25*	*0.1*	3.0
12/17/2003	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	1.1	*0.25*	*0.1*	2.7
1/7/2004	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	1.2	*0.25*	*0.1*	2.8
1/21/2004	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	1.5	*0.25*	*0.1*	3.1
2/6/2004	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	0.67	*0.25*	*0.1*	2.3
2/19/2004	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	0.57	*0.25*	*0.1*	2.2
3/3/2004	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	0.62	*0.25*	*0.1*	2.2
3/17/2004	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	*0.1*	1.9
4/14/2004	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	8.0
4/30/2004	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	8.0
5/21/2004	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	0.25	*0.25*	*0.1*	1.9
5/29/2004	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	0.6	*0.25*	*0.1*	2.2
6/11/2004	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	0.56	*0.25*	*0.1*	2.2
6/24/2004	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	0.77	*0.25*	*0.1*	2.4
7/9/2004	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	0.51	*0.25*	*0.1*	2.1
7/21/2004	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	0.64	*0.25*	0.23	2.4
8/6/2004	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	0.56	*0.25*	*0.1*	2.2
8/20/2004	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	0.52	*0.25*	*0.1*	2.1
9/3/2004	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	2.1	0.21	*0.25*	3.8
9/17/2004	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	0.7	0.22	*0.25*	2.4
10/1/2004	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	1.5	*0.1*	*0.25*	3.1
10/5/2004	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	1.3	*0.1*	*0.25*	2.9
11/2/2004	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	1.3	*0.1*	*0.25*	2.9
11/16/2004	*0.25*	*0.25*	*0.25*	*0.25*	*0.25*	1.5	*0.1*	*0.25*	3.1

Table B2 Summary of Effluent Data
Former Beloit Corporation -Blackhawk Facility
Rockton, Illinois

Sample Date	1,1-DCA	1,2-DCA	1,1-DCE	cis 1,2-DCE	trans 1,2-DCE	PCE	1,1,1-TCA	TCE	Total VOCS
12/7/2004	0.25	0.25	0.25	0.25	0.25	1.1	0.25	0.1	2.7
12/21/2004	0.25	0.25	0.25	0.25	0.25	0.87	0.25	0.1	2.5
1/4/2005	0.25	0.25	0.25	0.25	0.25	0.87	0.25	0.1	2.5
1/18/2005	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.1	1.9
2/1/2005	0.25	0.25	0.25	0.25	0.25	0.88	0.25	0.1	2.5
2/15/2005	0.25	0.25	0.25	0.25	0.25	0.64	0.25	0.1	2.2
3/8/2005	0.25	0.25	0.25	0.25	0.25	0.58	0.25	0.1	2.2
3/22/2005	0.25	0.25	0.25	0.25	0.25	0.63	0.25	0.1	2.2
4/5/2005	0.25	0.25	0.25	0.25	0.25	0.94	0.25	0.1	2.5
4/19/2005	0.25	0.25	0.25	0.25	0.25	0.96	0.25	0.1	2.6
5/3/2005	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.1	1.9
5/3/2005	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.1	1.9
5/17/2005	0.25	0.1	0.25	0.25	0.25	0.96	0.25	0.1	2.4
5/17/2005	0.25	0.1	0.25	0.25	0.25	0.96	0.25	0.1	2.4
~~9/29/2005~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~20.0~~
~~10/5/2005~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~20.0~~
~~10/18/2005~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~20.0~~
~~11/22/2005~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~20.0~~
~~11/30/2005~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~20.0~~
~~12/7/2005~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~20.0~~
~~12/21/2005~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~2.5~~	~~20.0~~
1/12/2006	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	4.5
1/26/2006	0.5	0.5	0.5	0.5	0.5	1.2	0.5	0.5	4.7
2/8/2006	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	4.5
2/22/2006	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	4.5
3/8/2006	0.5	0.5	0.5	0.5	0.5	1	0.5	0.5	4.5

Table B2 Summary of Effluent Data
Former Beloit Corporation -Blackhawk Facility
Rockton, Illinois

Sample Date	1,1-DCA	1,2-DCA	1,1-DCE	cis 1,2-DCE	trans 1,2-DCE	PCE	1,1,1-TCA	TCE	Total VOCS
3/17/2006	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	4.0
4/5/2006	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	1	*0.5*	*0.5*	4.5
4/19/2006	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	1	*0.5*	*0.5*	4.5
5/10/2006	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	1	*0.5*	*0.5*	4.5
5/17/2006	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	1	*0.5*	*0.5*	4.5
6/7/2006	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	4.0
6/21/2006	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	4.0
10/4/2006	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	4.0
10/18/2006	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	4.0
11/1/2006	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	4.0
11/20/2006	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	4.0
12/6/2006	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	4.0
12/20/2006	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	*0.5*	4.0

Note: *All concentrations are in micrograms per liter, data listed in italics were not detected and one half the detection limit was inserted. Finally, data with strike throughs were not used in the calculations.*

Attachment 3

Mass Balance Calculations

Mass Balance Calculations for 1,1-Dichloroethane (Maximum Influent Concentration)

Basis: 24-hours

Line	*Baseline Mass Loading*		Source
1	*Maximum Detected Influent Concentration:*	*ND µg/L*	*From Table 1*
2	Existing Influent Flow Rate:	244,000 gpd	From NPDES Permit Reports
3	Mass Loading:	0 µg or	Line 1 x Line 2 x 3.785 liters per gallon
4		0.0 grams	Line 3 / 1,000,000 micrograms per gram
5	Removal Efficiency	NC	From Table 3
6	Loading to River:	0.0 grams per day	(1 - Line 5) x Line 4
7	Discharge to Air:	0.0 grams per day	Line 4 - Line 6
	Mass Loading Associated With New Wells		
	MW23B		
8	Design Extraction Rate:	16 gpm or	Design Criteria
9		23,040 gpd	Line 8 x 60 min/hour x 24 hours/day
10	Influent Concentration:	5 µg/L	From Table 4
11	Mass Loading:	436,032 µg	Line 9 x Line 10 x 3.785 liters/gallon
	GW07		
12	Design Extraction Rate:	15 gpm or	Design Criteria
13		*21,600 gpd*	*Line 12 x 60 min/hour x 24 hours/day*
14	Influent Concentration:	1.6 µg/L	From Table 4
15	Mass Loading:	130,810 µg	Line 13 x Line 14 x 3.785 liters/gallon
	GW08		
16	Design Extraction Rate:	15 gpm or	Design Criteria
17		21,600 gpd	Line 16 x 60 min/hour x 24 hours/day
18	Influent Concentration:	1 µg/L	From Table 4
19	Mass Loading:	81,756 µg	Line 17 x Line 18 x 3.785 liters/gallon
	Combined (EW05, EW06 & EW07)		
20	Overall Extraction Rate:	66,240 gpd	Line 8 + Line 12 + Line 16
21	Mass Loading:	648598 µg	Line 11 + Line 15 + Line 19
	Overall System With New Wells		
22	Influent Flow Rate:	310,240 gpd	Line 2 + Line 20
23	Influent Mass Loading:	648,598 µg or	Line 3 + Line 21
24		0.6 grams	Line 24 / 1,000,000 micrograms per gram
25	Influent Concentration	0.6 µg/L	Line 23 / (Line 22 x 3.785 liters/gallon)
26	*Removal Efficiency:*	*88.7%*	*From Table 3 (Average VOC Removal Eff.)*
27	Loading to River	0.1 grams per day	Line 24 x (1 - Line 26)
28	Effluent Concentration:	0.1 µg/L	Line 23 / (Line 22 x 3.785 liters per gallon)
29	Discharge to Air:	0.6 grams per day	Line 24 - Line 27

Mass Balance Calculations for 1,1, 1- Trichloroethane (Maximum Influent Concentration)

Basis: 24-hours

Line	*Baseline Mass Loading*		Source
1	*Maximum Detected Influent Concentration:*	3.40 µg/L	*From Table 1*
2	Existing Influent Flow Rate:	244,000 gpd	From NPDES Permit Reports
3	Mass Loading:	3,140,036 µg or	Line 1 x Line 2 x 3.785 liters per gallon
4		3.1 grams	Line 3 / 1,000,000 micrograms per gram
5	Removal Efficiency:	81.2%	From Table 3
6	Loading to River:	0.6 grams per day	(1 - Line 5) x Line 4
7	Discharge to Air:	2.5 grams per day	Line 4 - Line 6
	Mass Loading Associated With New Wells		
	MW23B		
8	Design Extraction Rate:	16 gpm or	Design Criteria
9		23,040 gpd	Line 8 x 60 min/hour x 24 hours/day
10	Influent Concentration:	5 µg/L	From Table 4
11	Mass Loading:	436,032 µg	Line 9 x Line 10 x 3.785 liters/gallon
	GW07		
12	Design Extraction Rate:	15 gpm or	Design Criteria
13		21,600 gpd	Line 12 x 60 min/hour x 24 hours/day
14	Influent Concentration:	10 µg/L	From Table 4
15	Mass Loading:	817,560 µg	Line 13 x Line 14 x 3.785 liters/gallon
	GW08		
16	Design Extraction Rate:	15 gpm or	Design Criteria
17		21,600 gpd	Line 16 x 60 min/hour x 24 hours/day
18	Influent Concentration:	11 µg/L	From Table 4
19	Mass Loading:	899,316 µg	Line 17 x Line 18 x 3.785 liters/gallon
	Combined (EW05, EW06 & EW07)		
20	Overall Extraction Rate:	66,240 gpd	Line 8 + Line 12 + Line 16
21	Mass Loading:	2152908 µg	Line 11 + Line 15 + Line 19
	Overall System With New Wells		
22	Influent Flow Rate:	310,240 gpd	Line 2 + Line 20
23	Influent Mass Loading:	5,292,944 µg or	Line 3 + Line 21
24		5.3 grams	Line 24 / 1,000,000 micrograms per gram
25	Influent Concentration:	4.5 µg/L	Line 23 / (Line 22 x 3.785 liters/gallon)
26	*Removal Efficiency:*	*81.2%*	*From Table 3*
27	Loading to River:	1.0 grams per day	Line 24 x (1 - Line 26)
28	Effluent Concentration:	0.8 µg/L	Line 23 / (Line 22 x 3.785 liters per gallon)
29	Discharge to Air:	4.3 grams per day	Line 24 - Line 27

Mass Balance Calculations for 1,2-Dichloroethane (Maximum Influent Concentration)

Basis: 24-hours

Line	*Baseline Mass Loading*		Source
1	Maximum Detected Influent Concentration:	ND µg/L	From Table 1
2	Existing Influent Flow Rate:	244,000 gpd	From NPDES Permit Reports
3	Mass Loading:	0 µg or	Line 1 x Line 2 x 3.785 liters per gallon
4		0.0 grams	Line 3 / 1,000,000 micrograms per gram
5	Removal Efficiency	NC	From Table 3
6	Loading to River:	0.0 grams per day	(1 - Line 5) x Line 4
7	Discharge to Air	0.0 grams per day	Line 4 - Line 6
	Mass Loading Associated With New Wells		
	MW23B		
8	Design Extraction Rate.	16 gpm or	Design Criteria
9		23,040 gpd	Line 8 x 60 min/hour x 24 hours/day
10	Influent Concentration:	5 µg/L	From Table 4
11	Mass Loading:	436,032 µg	Line 9 x Line 10 x 3.785 liters/gallon
	GW07		
12	Design Extraction Rate.	15 gpm or	Design Criteria
13		21,600 gpd	Line 12 x 60 min/hour x 24 hours/day
14	Influent Concentration	0.5 µg/L	From Table 4
15	Mass Loading:	40,878 µg	Line 13 x Line 14 x 3.785 liters/gallon
	GW08		
16	Design Extraction Rate:	15 gpm or	Design Criteria
17		21,600 gpd	Line 16 x 60 min/hour x 24 hours/day
18	Influent Concentration:	1 µg/L	From Table 4
19	Mass Loading.	81,756 µg	Line 17 x Line 18 x 3.785 liters/gallon
	Combined (EW05, EW06 & EW07)		
20	Overall Extraction Rate:	66,240 gpd	Line 8 + Line 12 + Line 16
21	Mass Loading:	558666 µg	Line 11 + Line 15 + Line 19
	Overall System With New Wells		
22	Influent Flow Rate:	310,240 gpd	Line 2 + Line 20
23	Influent Mass Loading:	558,666 µg or	Line 3 + Line 21
24		0.6 grams	Line 24 / 1,000,000 micrograms per gram
25	Influent Concentration	0.5 µg/L	Line 23 / (Line 22 x 3.785 liters/gallon)
26	Removal Efficiency.	88.7%	From Table 3 (Average VOC Removal Eff.)
27	Loading to River:	0.1 grams per day	Line 24 x (1 - Line 26)
28	Effluent Concentration:	0.1 µg/L	Line 23 / (Line 22 x 3.785 liters per gallon)
29	Discharge to Air.	0.5 grams per day	Line 24 - Line 27

Mass Balance Calculations for cis 1,2-Dichloroethene (Maximum Influent Concentration)

Basis: 24-hours

Line	*Baseline Mass Loading*		Source
1	Maximum Detected Influent Concentration	2.54 µg/L	From Table 1
2	Existing Influent Flow Rate:	244,000 gpd	From NPDES Permit Reports
3	Mass Loading:	2,345,792 µg or	Line 1 x Line 2 x 3.785 liters per gallon
4		2.3 grams	Line 3 / 1,000,000 micrograms per gram
5	Removal Efficiency	88.7%	From Table 3 (Average VOC Removal Eff.)
6	Loading to River	0.3 grams per day	(1 - Line 5) x Line 4
7	Discharge to Air:	2.1 grams per day	Line 4 - Line 6
	Mass Loading Associated With New Wells		
	MW23B		
8	Design Extraction Rate:	16 gpm or	Design Criteria
9		23,040 gpd	Line 8 x 60 min/hour x 24 hours/day
10	Influent Concentration.	1200 µg/L	From Table 4
11	Mass Loading.	104,647,680 µg	Line 9 x Line 10 x 3.785 liters/gallon
	GW07		
12	Design Extraction Rate:	15 gpm or	Design Criteria
13		21,600 gpd	Line 12 x 60 min/hour x 24 hours/day
14	Influent Concentration	270 µg/L	From Table 4
15	Mass Loading:	22,074,120 µg	Line 13 x Line 14 x 3.785 liters/gallon
	GW08		
16	Design Extraction Rate:	15 gpm or	Design Criteria
17		21,600 gpd	Line 16 x 60 min/hour x 24 hours/day
18	Influent Concentration:	8.9 µg/L	From Table 4
19	Mass Loading:	727,628 µg	Line 17 x Line 18 x 3.785 liters/gallon
	Combined (EW05, EW06 & EW07)		
20	Overall Extraction Rate.	66,240 gpd	Line 8 + Line 12 + Line 16
21	Mass Loading:	127449428 µg	Line 11 + Line 15 + Line 19
	Overall System With New Wells		
22	Influent Flow Rate.	310,240 gpd	Line 2 + Line 20
23	Influent Mass Loading:	129,795,220 µg or	Line 3 + Line 21
24		129.8 grams	Line 24 / 1,000,000 micrograms per gram
25	Influent Concentration:	110.5 µg/L	Line 23 / (Line 22 x 3.785 liters/gallon)
26	Removal Efficiency	88.7%	From Table 3 (Average VOC Removal Eff.)
27	Loading to River.	14.6 grams per day	Line 24 x (1 - Line 26)
28	Effluent Concentration:	12.5 µg/L	Line 23 / (Line 22 x 3.785 liters per gallon)
29	Discharge to Air:	115.2 grams per day	Line 24 - Line 27

Mass Balance Calculations for trans 1,2 -Dichloroethene (Maximum Influent Concentration)

Basis: 24-hours

Line	*Baseline Mass Loading*		Source
1	Maximum Detected Influent Concentration:	ND μg/L	From Table 1
2	Existing Influent Flow Rate:	244,000 gpd	From NPDES Permit Reports
3	Mass Loading:	0 μg or	Line 1 x Line 2 x 3.785 liters per gallon
4		0.0 grams	Line 3 / 1,000,000 micrograms per gram
5	Removal Efficiency:	NC	From Table 3
6	Loading to River:	0.0 grams per day	(1 - Line 5) x Line 4
7	Discharge to Air:	0.0 grams per day	Line 4 - Line 6
	Mass Loading Associated With New Wells		
	MW23B		
8	Design Extraction Rate:	16 gpm or	Design Criteria
9		23,040 gpd	Line 8 x 60 min/hour x 24 hours/day
10	Influent Concentration.	23 μg/L	From Table 4
11	Mass Loading:	2,005,747 μg	Line 9 x Line 10 x 3.785 liters/gallon
	GW07		
12	Design Extraction Rate:	15 gpm or	Design Criteria
13		21,600 gpd	Line 12 x 60 min/hour x 24 hours/day
14	Influent Concentration:	4.6 μg/L	From Table 4
15	Mass Loading:	376,078 μg	Line 13 x Line 14 x 3.785 liters/gallon
	GW08		
16	Design Extraction Rate:	15 gpm or	Design Criteria
17		21,600 gpd	Line 16 x 60 min/hour x 24 hours/day
18	Influent Concentration:	0.1 μg/L	From Table 4
19	Mass Loading:	8,176 μg	Line 17 x Line 18 x 3.785 liters/gallon
	Combined (EW05, EW06 & EW07)		
20	Overall Extraction Rate:	66,240 gpd	Line 8 + Line 12 + Line 16
21	Mass Loading.	2390000 μg	Line 11 + Line 15 + Line 19
	Overall System With New Wells		
22	Influent Flow Rate:	310,240 gpd	Line 2 + Line 20
23	Influent Mass Loading:	2,390,000 μg or	Line 3 + Line 21
24		2.4 grams	Line 24 / 1,000,000 micrograms per gram
25	Influent Concentration:	2.0 μg/L	Line 23 / (Line 22 x 3.785 liters/gallon)
26	Removal Efficiency:	88.7%	From Table 3 (Average VOC Removal Eff.)
27	Loading to River:	0.3 grams per day	Line 24 x (1 - Line 26)
28	Effluent Concentration:	0.2 μg/L	Line 23 / (Line 22 x 3.785 liters per gallon)
29	Discharge to Air:	2.1 grams per day	Line 24 - Line 27

Mass Balance Calculations for Tetrachloroethene (Maximum Influent Concentration)

Basis: 24-hours

Line	*Baseline Mass Loading*		Source
1	Maximum Detected Influent Concentration:	130 μg/L	From Table 1
2	Existing Influent Flow Rate:	244,000 gpd	From NPDES Permit Reports
3	Mass Loading:	120,060,200 μg or	Line 1 x Line 2 x 3 785 liters per gallon
4		120.1 grams	Line 3 / 1,000,000 micrograms per gram
5	Removal Efficiency:	91.1%	From Table 3
6	Loading to River:	10.6 grams per day	(1 - Line 5) x Line 4
7	Discharge to Air:	109.4 grams per day	Line 4 - Line 6
	Mass Loading Associated With New Wells		
	MW23B		
8	Design Extraction Rate:	16 gpm or	Design Criteria
9		23,040 gpd	Line 8 x 60 min/hour x 24 hours/day
10	Influent Concentration:	1,600 μg/L	From Table 4
11	Mass Loading:	139,530,240 μg	Line 9 x Line 10 x 3.785 liters/gallon
	GW07		
12	Design Extraction Rate:	15 gpm or	Design Criteria
13		21,600 gpd	Line 12 x 60 min/hour x 24 hours/day
14	Influent Concentration:	2,300 μg/L	From Table 4
15	Mass Loading:	188,038,800 μg	Line 13 x Line 14 x 3.785 liters/gallon
	GW08		
16	Design Extraction Rate:	15 gpm or	Design Criteria
17		21,600 gpd	Line 16 x 60 min/hour x 24 hours/day
18	Influent Concentration:	880 μg/L	From Table 4
19	Mass Loading:	71,945,280 μg	Line 17 x Line 18 x 3.785 liters/gallon
	Combined (EW05, EW06 & EW07)		
20	Overall Extraction Rate:	66,240 gpd	Line 8 + Line 12 + Line 16
21	Mass Loading:	399,514,320 μg	Line 11 + Line 15 + Line 19
	Overall System With New Wells		
22	Influent Flow Rate:	310,240 gpd	Line 2 + Line 20
23	Influent Mass Loading:	519,574,520 μg or	Line 3 + Line 21
24		519.6 grams	Line 23 / 1,000,000 micrograms per gram
25	Influent Concentration:	442.5 μg/L	Line 23 / (Line 22 x 3.785 liters/gallon)
26	Removal Efficiency:	91.1%	From Table 3
27	Loading to River:	46.0 grams per day	Line 24 x (1 - Line 26)
28	Effluent Concentration:	39.2 μg/L	Line 23 / (Line 22 x 3.785 liters per gallon)
29	Discharge to Air:	473.6 grams per day	Line 24 - Line 27

Mass Balance Calculations for 1,1-Dichloroethene (Maximum Influent Concentration)

Basis: 24-hours

Line			Source
	Baseline Mass Loading		
1	Maximum Detected Influent Concentration:	1 µg/L	From Table 1
2	Existing Influent Flow Rate:	244,000 gpd	From NPDES Permit Reports
3	Mass Loading:	923,540 µg or	Line 1 x Line 2 x 3.785 liters per gallon
4		0.9 grams	Line 3 / 1,000,000 micrograms per gram
5	Removal Efficiency:	64.0%	From Table 3
6	Loading to River:	0.3 grams per day	(1 - Line 5) x Line 4
7	Discharge to Air:	0.6 grams per day	Line 4 - Line 6
	Mass Loading Associated With New Wells		
	MW23B		
8	Design Extraction Rate:	16 gpm or	Design Criteria
9		23,040 gpd	Line 8 x 60 min/hour x 24 hours/day
10	Influent Concentration:	5 µg/L	From Table 4
11	Mass Loading:	436,032 µg	Line 9 x Line 10 x 3.785 liters/gallon
	GW07		
12	Design Extraction Rate	15 gpm or	Design Criteria
13		21,600 gpd	Line 12 x 60 min/hour x 24 hours/day
14	Influent Concentration:	2 µg/L	From Table 4
15	Mass Loading:	163,512 µg	Line 13 x Line 14 x 3.785 liters/gallon
	GW08		
16	Design Extraction Rate:	15 gpm or	Design Criteria
17		21,600 gpd	Line 16 x 60 min/hour x 24 hours/day
18	Influent Concentration:	1 µg/L	From Table 4
19	Mass Loading:	81,756 µg	Line 17 x Line 18 x 3.785 liters/gallon
	Combined (EW05, EW06 & EW07)		
20	Overall Extraction Rate:	66,240 gpd	Line 8 + Line 12 + Line 16
21	Mass Loading:	681300 µg	Line 11 + Line 15 + Line 19
	Overall System With New Wells		
22	Influent Flow Rate:	310,240 gpd	Line 2 + Line 20
23	Influent Mass Loading:	1,604,840 µg or	Line 3 + Line 21
24		1.6 grams	Line 24 / 1,000,000 micrograms per gram
25	Influent Concentration:	1.4 µg/L	Line 23 / (Line 22 x 3.785 liters/gallon)
26	Removal Efficiency:	88.7%	From Table 3 (Average VOC Removal Eff.)
27	Loading to River:	0.2 grams per day	Line 24 x (1 - Line 26)
28	Effluent Concentration:	0.2 µg/L	Line 23 / (Line 22 x 3.785 liters per gallon)
29	Discharge to Air	1.4 grams per day	Line 24 - Line 27

Mass Balance Calculations for Trichloroethene (Maximum Influent Concentration)

Basis: 24-hours

Line			Source
	Baseline Mass Loading		
1	Maximum Detected Influent Concentration:	5.33 µg/L	From Table 1
2	Existing Influent Flow Rate:	244,000 gpd	From NPDES Permit Reports
3	Mass Loading:	4,922,468 µg or	Line 1 x Line 2 x 3.785 liters per gallon
4		4.9 grams	Line 3 / 1,000,000 micrograms per gram
5	Removal Efficiency:	80.0%	From Table 3
6	Loading to River:	1.0 grams per day	(1 - Line 5) x Line 4
7	Discharge to Air:	3.9 grams per day	Line 4 - Line 6
	Mass Loading Associated With New Wells		
	MW23B		
8	Design Extraction Rate:	16 gpm or	Design Criteria
9		23,040 gpd	Line 8 x 60 min/hour x 24 hours/day
10	Influent Concentration:	52 µg/L	From Table 4
11	Mass Loading:	4,534,733 µg	Line 9 x Line 10 x 3.785 liters/gallon
	GW07		
12	Design Extraction Rate:	15 gpm or	Design Criteria
13		21,600 gpd	Line 12 x 60 min/hour x 24 hours/day
14	Influent Concentration:	58 µg/L	From Table 4
15	Mass Loading:	4,741,848 µg	Line 13 x Line 14 x 3.785 liters/gallon
	GW08		
16	Design Extraction Rate:	15 gpm or	Design Criteria
17		21,600 gpd	Line 16 x 60 min/hour x 24 hours/day
18	Influent Concentration:	5.2 µg/L	From Table 4
19	Mass Loading:	425,131 µg	Line 17 x Line 18 x 3.785 liters/gallon
	Combined (EW05, EW06 & EW07)		
20	Overall Extraction Rate:	66,240 gpd	Line 8 + Line 12 + Line 16
21	Mass Loading:	9,701,712 µg	Line 11 + Line 15 + Line 19
	Overall System With New Wells		
22	Influent Flow Rate:	310,240 gpd	Line 2 + Line 20
23	Influent Mass Loading:	14,624,180 µg or	Line 3 + Line 21
24		14.6 grams	Line 24 / 1,000,000 micrograms per gram
25	Influent Concentration:	12.5 µg/L	Line 23 / (Line 22 x 3.785 liters/gallon)
26	Removal Efficiency:	80.0%	From Table 3
27	Loading to River:	2.9 grams per day	Line 24 x (1 - Line 26)
28	Effluent Concentration:	2.5 µg/L	Line 23 / (Line 22 x 3.785 liters per gallon)
29	Discharge to Air:	11.7 grams per day	Line 24 - Line 27

Mass Balance Calculations for 1,1-Dichloroethane (Average Influent Concentration)

Basis: 24-hours

Line	*Baseline Mass Loading*		Source
1	*Average Detected Influent Concentration:*	ND µg/L	From Table 1
2	Existing Influent Flow Rate.	244,000 gpd	From NPDES Permit Reports
3	Mass Loading	0 µg or	Line 1 x Line 2 x 3.785 liters per gallon
4		0.0 grams	Line 3 / 1,000,000 micrograms per gram
5	Removal Efficiency	NC	From Table 3
6	Loading to River:	0.0 grams per day	(1 - Line 5) x Line 4
7	*Discharge to Air:*	*0 0 grams per day*	*Line 4 - Line 6*
	Mass Loading Associated With New Wells		
	MW23B		
8	Design Extraction Rate:	16 gpm or	Design Criteria
9		23,040 gpd	Line 8 x 60 min/hour x 24 hours/day
10	Influent Concentration	5 µg/L	From Table 4
11	*Mass Loading:*	*436,032 µg*	*Line 9 x Line 10 x 3.785 liters/gallon*
	GW07		
12	Design Extraction Rate:	15 gpm or	Design Criteria
13		21,600 gpd	Line 12 x 60 min/hour x 24 hours/day
14	Influent Concentration:	1.6 µg/L	From Table 4
15	Mass Loading:	130,810 µg	Line 13 x Line 14 x 3.785 liters/gallon
	GW08		
16	Design Extraction Rate:	15 gpm or	Design Criteria
17		21,600 gpd	Line 16 x 60 min/hour x 24 hours/day
18	Influent Concentration	1 µg/L	From Table 4
19	Mass Loading:	81,756 µg	Line 17 x Line 18 x 3.785 liters/gallon
	Combined (EW05, EW06 & EW07)		
20	*Overall Extraction Rate:*	*66,240 gpd*	*Line 8 + Line 12 + Line 16*
21	Mass Loading:	648598 µg	Line 11 + Line 15 + Line 19
	Overall System With New Wells		
22	Influent Flow Rate.	310,240 gpd	Line 2 + Line 20
23	Influent Mass Loading	648,598 µg or	Line 3 + Line 21
24		0.6 grams	Line 24 / 1,000,000 micrograms per gram
25	Influent Concentration:	0.6 µg/L	Line 23 / (Line 22 x 3 785 liters/gallon)
26	Removal Efficiency	88.7%	From Table 3 (Average VOC Removal Eff.)
27	Loading to River:	0 1 grams per day	Line 24 x (1 - Line 26)
28	Effluent Concentration.	0.1 µg/L	Line 23 / (Line 22 x 3.785 liters per gallon)
29	Discharge to Air.	0.6 grams per day	Line 24 - Line 27

Mass Balance Calculations for 1,1, 1- Trichloroethane (Average Influent Concentration)

Basis: 24-hours

Line	*Baseline Mass Loading*		Source
1	Average Detected Influent Concentration:	1.86 µg/L	From Table 1
2	Existing Influent Flow Rate:	244,000 gpd	From NPDES Permit Reports
3	Mass Loading	1,714,706 µg or	Line 1 x Line 2 x 3 785 liters per gallon
4		1.7 grams	Line 3 / 1,000,000 micrograms per gram
5	Removal Efficiency	81.2%	From Table 3
6	Loading to River	0.3 grams per day	(1 - Line 5) x Line 4
7	*Discharge to Air.*	*1 4 grams per day*	*Line 4 - Line 6*
	Mass Loading Associated With New Wells		
	MW23B		
8	Design Extraction Rate	16 gpm or	Design Criteria
9		23,040 gpd	Line 8 x 60 min/hour x 24 hours/day
10	Influent Concentration:	5 µg/L	From Table 4
11	*Mass Loading:*	*436,032 µg*	*Line 9 x Line 10 x 3 785 liters/gallon*
	GW07		
12	Design Extraction Rate.	15 gpm or	Design Criteria
13		21,600 gpd	Line 12 x 60 min/hour x 24 hours/day
14	Influent Concentration	10 µg/L	From Table 4
15	Mass Loading:	817,560 µg	Line 13 x Line 14 x 3.785 liters/gallon
	GW08		
16	Design Extraction Rate:	15 gpm or	Design Criteria
17		21,600 gpd	Line 16 x 60 min/hour x 24 hours/day
18	Influent Concentration:	11 µg/L	From Table 4
19	Mass Loading.	899,316 µg	Line 17 x Line 18 x 3.785 liters/gallon
	Combined (EW05, EW06 & EW07)		
20	*Overall Extraction Rate:*	66,240 gpd	*Line 8 + Line 12 + Line 16*
21	Mass Loading:	2152908 µg	Line 11 + Line 15 + Line 19
	Overall System With New Wells		
22	Influent Flow Rate	310,240 gpd	Line 2 + Line 20
23	Influent Mass Loading	3,867,614 µg or	Line 3 + Line 21
24		3 9 grams	Line 24 / 1,000,000 micrograms per gram
25	Influent Concentration:	3 3 µg/L	Line 23 / (Line 22 x 3.785 liters/gallon)
26	Removal Efficiency:	81.2%	From Table 3
27	Loading to River:	0 7 grams per day	Line 24 x (1 - Line 26)
28	Effluent Concentration	0 6 µg/L	Line 23 / (Line 22 x 3.785 liters per gallon)
29	Discharge to Air:	3.1 grams per day	Line 24 - Line 27

Mass Balance Calculations for 1,2-Dichloroethane (Average Influent Concentration)

Basis: 24-hours

Line	*Baseline Mass Loading*		Source
1	Average Detected Influent Concentration	ND µg/L	From Table 1
2	Existing Influent Flow Rate:	244,000 gpd	From NPDES Permit Reports
3	Mass Loading	0 µg or	Line 1 x Line 2 x 3.785 liters per gallon
4		0.0 grams	Line 3 / 1,000,000 micrograms per gram
5	Removal Efficiency:	NC	From Table 3
6	Loading to River:	0.0 grams per day	(1 - Line 5) x Line 4
7	Discharge to Air:	0.0 grams per day	Line 4 - Line 6
	Mass Loading Associated With New Wells		
	<u>MW23B</u>		
8	Design Extraction Rate	16 gpm or	Design Criteria
9		23,040 gpd	Line 8 x 60 min/hour x 24 hours/day
10	Influent Concentration:	5 µg/L	From Table 4
11	Mass Loading:	436,032 µg	Line 9 x Line 10 x 3.785 liters/gallon
	<u>GW07</u>		
12	*Design Extraction Rate:*	*15 gpm or*	*Design Criteria*
13		21,600 gpd	Line 12 x 60 min/hour x 24 hours/day
14	Influent Concentration:	0.5 µg/L	From Table 4
15	Mass Loading:	40,878 µg	Line 13 x Line 14 x 3.785 liters/gallon
	<u>GW08</u>		
16	Design Extraction Rate:	15 gpm or	Design Criteria
17		21,600 gpd	Line 16 x 60 min/hour x 24 hours/day
18	Influent Concentration:	1 µg/L	From Table 4
19	Mass Loading:	81,756 µg	Line 17 x Line 18 x 3.785 liters/gallon
	<u>Combined (EW05, EW06 & EW07)</u>		
20	Overall Extraction Rate	66,240 gpd	Line 8 + Line 12 + Line 16
21	Mass Loading:	558666 µg	Line 11 + Line 15 + Line 19
	Overall System With New Wells		
22	Influent Flow Rate:	310,240 gpd	Line 2 + Line 20
23	Influent Mass Loading:	558,666 µg or	Line 3 + Line 21
24		0.6 grams	Line 24 / 1,000,000 micrograms per gram
25	*Influent Concentration*	*0.5 µg/L*	*Line 23 / (Line 22 x 3.785 liters/gallon)*
26	Removal Efficiency:	88.7%	From Table 3 (Average VOC Removal Eff.)
27	Loading to River:	0.1 grams per day	Line 24 x (1 - Line 26)
28	Effluent Concentration:	0.1 µg/L	Line 23 / (Line 22 x 3.785 liters per gallon)
29	Discharge to Air:	0.5 grams per day	Line 24 - Line 27

Mass Balance Calculations for cis 1,2-Dichloroethene (Average Influent Concentration)

Basis: 24-hours

Line	*Baseline Mass Loading*		Source
1	*Average Detected Influent Concentration:*	*1.02 µg/L*	*From Table 1*
2	Existing Influent Flow Rate	244,000 gpd	From NPDES Permit Reports
3	Mass Loading:	941,241 µg or	Line 1 x Line 2 x 3.785 liters per gallon
4		0.9 grams	Line 3 / 1,000,000 micrograms per gram
5	Removal Efficiency:	88.7%	From Table 3 (Average VOC Removal Eff.)
6	Loading to River:	0.1 grams per day	(1 - Line 5) x Line 4
7	Discharge to Air:	0.8 grams per day	Line 4 - Line 6
	Mass Loading Associated With New Wells		
	<u>MW23B</u>		
8	Design Extraction Rate:	16 gpm or	Design Criteria
9		23,040 gpd	Line 8 x 60 min/hour x 24 hours/day
10	Influent Concentration:	1200 µg/L	From Table 4
11	Mass Loading	104,647,680 µg	Line 9 x Line 10 x 3.785 liters/gallon
	<u>GW07</u>		
12	*Design Extraction Rate:*	*15 gpm or*	*Design Criteria*
13		21,600 gpd	Line 12 x 60 min/hour x 24 hours/day
14	Influent Concentration:	270 µg/L	From Table 4
15	Mass Loading	22,074,120 µg	Line 13 x Line 14 x 3.785 liters/gallon
	<u>GW08</u>		
16	Design Extraction Rate:	15 gpm or	Design Criteria
17		21,600 gpd	Line 16 x 60 min/hour x 24 hours/day
18	Influent Concentration:	8.9 µg/L	From Table 4
19	Mass Loading	727,628 µg	Line 17 x Line 18 x 3.785 liters/gallon
	<u>Combined (EW05, EW06 & EW07)</u>		
20	Overall Extraction Rate:	66,240 gpd	Line 8 + Line 12 + Line 16
21	Mass Loading:	127449428 µg	Line 11 + Line 15 + Line 19
	Overall System With New Wells		
22	Influent Flow Rate:	310,240 gpd	Line 2 + Line 20
23	Influent Mass Loading:	128,390,670 µg or	Line 3 + Line 21
24		128.4 grams	Line 24 / 1,000,000 micrograms per gram
25	Influent Concentration:	109.3 µg/L	Line 23 / (Line 22 x 3.785 liters/gallon)
26	Removal Efficiency:	88.7%	From Table 3 (Average VOC Removal Eff.)
27	Loading to River:	14.5 grams per day	Line 24 x (1 - Line 26)
28	Effluent Concentration	12.3 µg/L	Line 23 / (Line 22 x 3.785 liters per gallon)
29	Discharge to Air:	113.9 grams per day	Line 24 - Line 27

Mass Balance Calculations for trans 1,2 -Dichloroethene (Average Influent Concentration)

Basis: 24-hours

Line	*Baseline Mass Loading*		Source
1	Average Detected Influent Concentration:	ND µg/L	From Table 1
2	Existing Influent Flow Rate:	244,000 gpd	From NPDES Permit Reports
3	Mass Loading:	0 µg or	Line 1 x Line 2 x 3.785 liters per gallon
4		0.0 grams	Line 3 / 1,000,000 micrograms per gram
5	Removal Efficiency:	NC	From Table 3
6	Loading to River:	0.0 grams per day	(1 - Line 5) x Line 4
7	Discharge to Air:	0.0 grams per day	Line 4 - Line 6
	Mass Loading Associated With New Wells		
	MW23B		
8	Design Extraction Rate:	16 gpm or	Design Criteria
9		23,040 gpd	Line 8 x 60 min/hour x 24 hours/day
10	Influent Concentration:	23 µg/L	From Table 4
11	Mass Loading:	2,005,747 µg	Line 9 x Line 10 x 3.785 liters/gallon
	GW07		
12	Design Extraction Rate:	15 gpm or	Design Criteria
13		21,600 gpd	Line 12 x 60 min/hour x 24 hours/day
14	Influent Concentration:	4.6 µg/L	From Table 4
15	Mass Loading:	376,078 µg	Line 13 x Line 14 x 3.785 liters/gallon
	GW08		
16	Design Extraction Rate:	15 gpm or	Design Criteria
17		21,600 gpd	Line 16 x 60 min/hour x 24 hours/day
18	Influent Concentration:	0.1 µg/L	From Table 4
19	Mass Loading:	8,176 µg	Line 17 x Line 18 x 3.785 liters/gallon
	Combined (EW05, EW06 & EW07)		
20	Overall Extraction Rate:	66,240 gpd	Line 8 + Line 12 + Line 16
21	Mass Loading:	2390000 µg	Line 11 + Line 15 + Line 19
	Overall System With New Wells		
22	Influent Flow Rate:	310,240 gpd	Line 2 + Line 20
23	Influent Mass Loading:	2,390,000 µg or	Line 3 + Line 21
24		2.4 grams	Line 24 / 1,000,000 micrograms per gram
25	Influent Concentration:	2.0 µg/L	Line 23 / (Line 22 x 3.785 liters/gallon)
26	Removal Efficiency:	88.7%	From Table 3 (Average VOC Removal Eff.)
27	Loading to River.	0.3 grams per day	Line 24 x (1 - Line 26)
28	Effluent Concentration:	0.2 µg/L	Line 23 / (Line 22 x 3.785 liters per gallon)
29	Discharge to Air:	2.1 grams per day	Line 24 - Line 27

Mass Balance Calculations for Tetrachloroethene (Average Influent Concentration)

Basis: 24-hours

Line	*Baseline Mass Loading*		Source
1	Average Detected Influent Concentration:	50.72 µg/L	From Table 1
2	Existing Influent Flow Rate:	244,000 gpd	From NPDES Permit Reports
3	Mass Loading:	46,841,949 µg or	Line 1 x Line 2 x 3.785 liters per gallon
4		46.8 grams	Line 3 / 1,000,000 micrograms per gram
5	Removal Efficiency:	91.1%	From Table 3
6	Loading to River:	4.1 grams per day	(1 - Line 5) x Line 4
7	Discharge to Air:	42.7 grams per day	Line 4 - Line 6
	Mass Loading Associated With New Wells		
	MW23B		
8	Design Extraction Rate:	16 gpm or	Design Criteria
9		23,040 gpd	Line 8 x 60 min/hour x 24 hours/day
10	Influent Concentration:	1,600 µg/L	From Table 4
11	Mass Loading:	139,530,240 µg	Line 9 x Line 10 x 3.785 liters/gallon
	GW07		
12	Design Extraction Rate:	15 gpm or	Design Criteria
13		21,600 gpd	Line 12 x 60 min/hour x 24 hours/day
14	Influent Concentration:	2,300 µg/L	From Table 4
15	Mass Loading:	188,038,800 µg	Line 13 x Line 14 x 3.785 liters/gallon
	GW08		
16	Design Extraction Rate:	15 gpm or	Design Criteria
17		21,600 gpd	Line 16 x 60 min/hour x 24 hours/day
18	Influent Concentration:	880 µg/L	From Table 4
19	Mass Loading:	71,945,280 µg	Line 17 x Line 18 x 3.785 liters/gallon
	Combined (EW05, EW06 & EW07)		
20	Overall Extraction Rate:	66,240 gpd	Line 8 + Line 12 + Line 16
21	Mass Loading:	399,514,320 µg	Line 11 + Line 15 + Line 19
	Overall System With New Wells		
22	Influent Flow Rate:	310,240 gpd	Line 2 + Line 20
23	Influent Mass Loading:	446,356,269 µg or	Line 3 + Line 21
24		446.4 grams	Line 23 / 1,000,000 micrograms per gram
25	Influent Concentration:	380.1 µg/L	Line 23 / (Line 22 x 3.785 liters/gallon)
26	Removal Efficiency:	91 1%	From Table 3
27	Loading to River:	39.5 grams per day	Line 24 x (1 - Line 26)
28	Effluent Concentration:	33.7 µg/L	Line 23 / (Line 22 x 3.785 liters per gallon)
29	Discharge to Air:	406.8 grams per day	Line 24 - Line 27

Mass Balance Calculations for 1,1-Dichloroethene (Average Influent Concentration)

Basis: 24-hours

Line	*Baseline Mass Loading*		Source
1	Average Detected Influent Concentration:	0.70 µg/L	From Table 1
2	Existing Influent Flow Rate:	244,000 gpd	From NPDES Permit Reports
3	Mass Loading:	641,860 µg or	Line 1 x Line 2 x 3.785 liters per gallon
4		0.6 grams	*Line 3 / 1,000,000 micrograms per gram*
5	Removal Efficiency	88.7%	From Table 3 (Average VOC Removal Eff.)
6	Loading to River:	0.1 grams per day	(1 - Line 5) x Line 4
7	Discharge to Air:	0.6 grams per day	Line 4 - Line 6
	Mass Loading Associated With New Wells		
	MW23B		
8	Design Extraction Rate:	16 gpm or	Design Criteria
9		23,040 gpd	Line 8 x 60 min/hour x 24 hours/day
10	Influent Concentration:	5 µg/L	From Table 4
11	Mass Loading	436,032 µg	Line 9 x Line 10 x 3.785 liters/gallon
	GW07		
12	Design Extraction Rate:	15 gpm or	Design Criteria
13		*21,600 gpd*	*Line 12 x 60 min/hour x 24 hours/day*
14	Influent Concentration:	2 µg/L	From Table 4
15	Mass Loading:	163,512 µg	Line 13 x Line 14 x 3.785 liters/gallon
	GW08		
16	Design Extraction Rate.	15 gpm or	Design Criteria
17		21,600 gpd	Line 16 x 60 min/hour x 24 hours/day
18	Influent Concentration.	1 µg/L	From Table 4
19	Mass Loading:	81,756 µg	Line 17 x Line 18 x 3.785 liters/gallon
	Combined (EW05, EW06 & EW07)		
20	Overall Extraction Rate:	66,240 gpd	Line 8 + Line 12 + Line 16
21	Mass Loading.	681300 µg	Line 11 + Line 15 + Line 19
	Overall System With New Wells		
22	Influent Flow Rate:	310,240 gpd	Line 2 + Line 20
23	Influent Mass Loading	1,323,160 µg or	Line 3 + Line 21
24		1.3 grams	Line 24 / 1,000,000 micrograms per gram
25	Influent Concentration:	1.1 µg/L	Line 23 / (Line 22 x 3.785 liters/gallon)
26	Removal Efficiency:	88.7%	From Table 3
27	Loading to River:	0.1 grams per day	Line 24 x (1 - Line 26)
28	Effluent Concentration:	0.1 µg/L	Line 23 / (Line 22 x 3.785 liters per gallon)
29	Discharge to Air:	1.2 grams per day	Line 24 - Line 27

Mass Balance Calculations for Trichloroethene (Average Influent Concentration)

Basis: 24-hours

Line	*Baseline Mass Loading*		Source
1	Average Detected Influent Concentration:	2.24 µg/L	From Table 1
2	Existing Influent Flow Rate:	244,000 gpd	From NPDES Permit Reports
3	Mass Loading:	2,064,625 µg or	Line 1 x Line 2 x 3.785 liters per gallon
4		2.1 grams	Line 3 / 1,000,000 micrograms per gram
5	Removal Efficiency:	80.0%	From Table 3
6	Loading to River:	0.4 grams per day	(1 - Line 5) x Line 4
7	Discharge to Air:	1.7 grams per day	Line 4 - Line 6
	Mass Loading Associated With New Wells		
	MW23B		
8	Design Extraction Rate:	16 gpm or	Design Criteria
9		23,040 gpd	Line 8 x 60 min/hour x 24 hours/day
10	Influent Concentration:	52 µg/L	*From Table 4*
11	Mass Loading	4,534,733 µg	Line 9 x Line 10 x 3.785 liters/gallon
	GW07		
12	Design Extraction Rate:	15 gpm or	Design Criteria
13		21,600 gpd	*Line 12 x 60 min/hour x 24 hours/day*
14	Influent Concentration.	58 µg/L	From Table 4
15	Mass Loading:	4,741,848 µg	Line 13 x Line 14 x 3.785 liters/gallon
	GW08		
16	Design Extraction Rate:	15 gpm or	Design Criteria
17		21,600 gpd	Line 16 x 60 min/hour x 24 hours/day
18	Influent Concentration:	5.2 µg/L	From Table 4
19	Mass Loading:	425,131 µg	Line 17 x Line 18 x 3.785 liters/gallon
	Combined (EW05, EW06 & EW07)		
20	Overall Extraction Rate:	66,240 gpd	Line 8 + Line 12 + Line 16
21	Mass Loading.	9,701,712 µg	Line 11 + Line 15 + Line 19
	Overall System With New Wells		
22	Influent Flow Rate	310,240 gpd	Line 2 + Line 20
23	Influent Mass Loading.	11,766,337 µg or	Line 3 + Line 21
24		11.8 grams	Line 24 / 1,000,000 micrograms per gram
25	Influent Concentration:	10.0 µg/L	Line 23 / (Line 22 x 3.785 liters/gallon)
26	Removal Efficiency:	80.0%	From Table 3
27	Loading to River:	2.4 grams per day	Line 24 x (1 - Line 26)
28	Effluent Concentration:	2.0 µg/L	Line 23 / (Line 22 x 3.785 liters per gallon)
29	Discharge to Air.	9.4 grams per day	Line 24 - Line 27

D

D

Equalizing Flow Pressure Technical Memorandum

Memorandum

ecology & environment engineering, inc.
International Specialists in the Environment

Date: May 8, 2007

To: Beloit 95% Design File

Prepared by: Tom Campbell, P.E.

Checked by: Neil Brown, P.E.

Subject: Equalizing Flow Pressure

Objective

The objective of this technical memorandum is to provide justification for the equalization of flow pressures associated with the Beloit pump-and-treat (P&T) system. The remedy takes into account the new piping layout associated with the installation of extraction wells EW05, EW06, and EW07, which are part of the groundwater extraction enhancements. The solution also considers future addition or removal of extraction wells.

For the Beloit site, the remedy includes the installation of three additional extraction wells to supplement the existing four extraction wells (EW01, EW02, EW03, EW04-Pump1, and EW04-Pump2). The new wells will be placed to concentrate on the source area plume to achieve a faster time frame for meeting the groundwater clean-up objectives (as opposed to using the current edge of source and downgradient extraction well locations [E & E 2007]).

Extracted groundwater is treated via air stripping and discharged under a National Pollutant Discharge Elimination System (NPDES) permit to the Rock River.

Design Considerations

Pressure Equalization: The existing system was constructed with all force mains joining into a single manifold pipe. This setup does not allow for a zero (atmospheric) pressure point within the system piping, such as when an equalization tank is used. Therefore, the system needs to either be balanced such that all line pressures entering the manifold are equal or be reconfigured so that a zero pressure point is located within the system. There are several options available for achieving equal flow pressures, which include:

- Sizing all pumps to achieve equal pressure at the manifold;

- Sizing pumps to achieve an equal pressure within two or more manifolds with separate connections to the air stripper; or

- Installing an equalization tank with transfer pump supplying the existing single manifold to the air stripper.

Discussion

Determining the Need for Pressure Equalization

When water is brought by pipes to a junction and where more than two pipes meet, two equations must be satisfied. The total amount of water brought into the junction must always equal the amount of water carried away from the junction, and all pipes that meet at the junction must share the same pressure at that junction (Hwang 1987). Therefore, when the pipes enter the manifold pipe, the pressure at each pipe entrance and the pressure at that point within the manifold are equal. If one of the pipes entering the manifold has a much greater pressure gradient than another pipe entering the system, the pipe with the greater pressure will "step on" the pipe with the least pressure, which reduces/stops flow from the low-pressure line.

At the Beloit Corporation, this theory was tested on EW02. With all of the extraction wells in operation, EW02 had a flowrate of 10 gallons per minute (gpm). When all of the wells were shut down and EW02 ran alone, the flowrate increased to 16 gpm. This translates into an increased flow of 60% over what is being achieved under normal operating conditions, when EW03, EW04-1, and EW04-2 are continuously running.

Based on calculations performed using existing flow from the extraction wells, it was found that some current and proposed wells would be "stepped on" if a single manifold system is used. Pressure calculations show that EW03, EW04-1, and EW04-2 have pressure gradients within the same range of one another, meaning that they can share the same manifold without significant interference of one another. While the proposed wells, EW05, EW06, and EW07, also have pressures within similar ranges, their operational pressures would be "stepped on" if they shared a manifold. The pressures from EW01 and EW02 fall below the pressure range of any of the other pumps.

Option 1: Sizing all pumps to achieve equal pressure at the manifold. To achieve equal pressure at the manifold, all of the pumps currently in the system would be re-sized. This would result in the extraction wells being able to deliver the design flowrate. However, in order to achieve this, many of the pumps would have to be oversized to overcome the pressure head created by the larger pumps. Assuming 75% motor efficiency and $0.10 per kilowatt-hour (kWh), a 1-horsepower (hp) pump costs $900 per year to operate (EPA 2005). With eight extraction well pumps operating at the site, it was assumed that five pumps would need to be oversized by 4 hp each to overcome a pressure head difference through a manifold system, which translates to $18,000 per year or $270,000 over 15 years of additional operational costs.

Additionally, individual well flowrates cannot be changed without adjusting the flowrates of all of the wells connected to the manifold. Potential upgrades to the system would require all of the pumps to be re-sized and could possibly result in the need to change out additional pumps.

Option 2: Sizing pumps to achieve an equal pressure within two or more manifolds with separate connections to the air stripper. If more than one manifold is used, pumps having similar pressures could be tied into a manifold, which would prevent flow reductions. This would allow for the wells to maintain the pumps that are currently installed. It would be preferable to minimize the number of manifolds, since tying into the top of the air stripper will require cutting a pipe access hole, welding a pipe connector to the air stripper, installing a diffuser, installing a pipe run through the building roof, and weatherproofing the exit location through the roof for each manifold installed. Additionally, each manifold would require a freeze protection solenoid, similar to the one already installed on the current manifold pipe run, with connection to the control panel and programmable logic controller (PLC) program.

Based on current conditions, two to three manifolds would be required, dependent on whether one pump would be re-sized. After installation, individual well flowrates cannot be changed without changing the flowrates of all of the wells connected to the same manifold. Potential upgrades to the system could require all of the pumps to be re-sized and could possibly result in the need to change out additional pumps or the need for installing an additional manifold.

Option 3: Installing an equalization tank with transfer pump supplying the existing single manifold to the air stripper. Equalization tanks provide process control (Reynolds 1982). If an equalization tank is added, then all wells can discharge into it, which creates a zero pressure point at the pipe discharge location. The equalization tank would have a transfer pump to send the water through the air stripper using the existing manifold pipe, which already has the freeze protection solenoid installed.

Two options are available under this scenario. First, an insulated tank located outside the building would be installed, or, second, a new building to house the tank could be built. The construction of a building is a preferred option since it provides several benefits. A non-insulated tank is less expensive than an insulated tank. With a building installed, influent and effluent lines will not require heat tape to prevent freezing, and the option to equip the tank with a sight gauge is available. The equipment, including tank, transfer pump, electric, and control boxes, would not be exposed to the elements or to accidental contact. The building will also allow for storage at the site that can be used when staging equipment for sampling events. It will also provide a quiet area since it will be a separate building from the one containing the air stripper. For these reasons, a building is considered a better option when using an equalization tank.

Finally, Option 3 provides the best scenario for future additions or deletions to the system. With an equalization tank, the flowrate from each existing well can be precisely controlled and additional wells can be added without affecting existing flowrates.

Conclusion

Option 3 provides the most flexibility for future system modifications, and increases the sustainability of the system by bringing it to engineering standards. The initial costs may be offset by not needing to oversize any of the extraction well pumps and savings associated with the cost of electricity.

References

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United States Army Corps of Engineers, 2002, *Liquid Process Piping*, Engineering and Design Manual 1110-1-4008 Change 1, Washington, D.C., September 16, 2002.

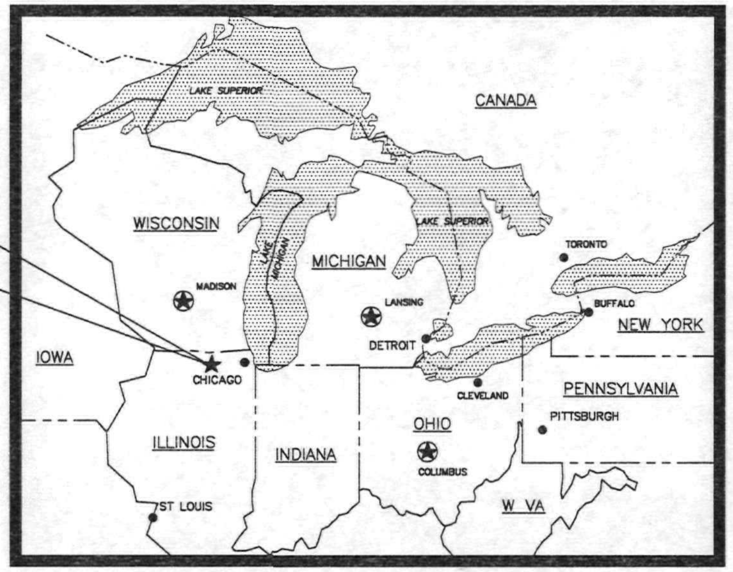
United States Environmental Protection Agency (EPA), 2005, *Guidance Document: Cost Effective Design of Pump and Treat Systems)*, Office of Solid Waste and Emergency Response, Washington, D.C., EPA/542/R-05/008.

E

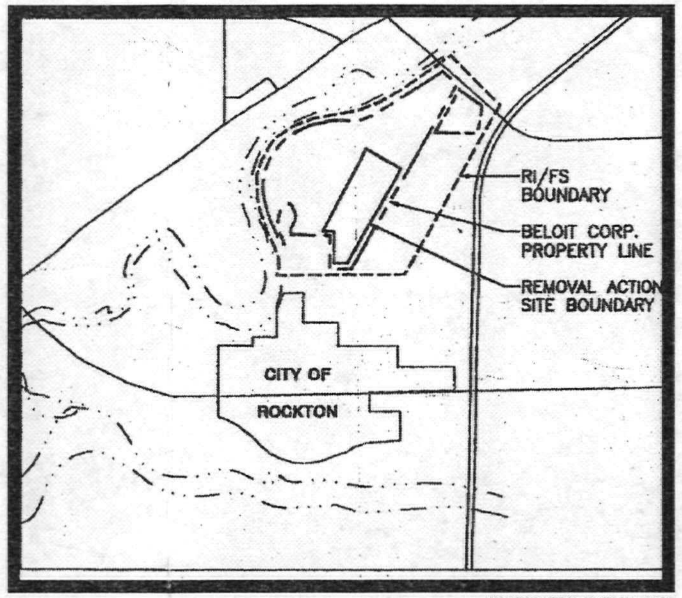
Sheets 1 through 9 of the 95% Remedial Action Design Drawing Set (Half-Size)

REMEDIAL ACTION 95% DESIGN
BELOIT CORPORATION

BLACKHAWK FACILITY
ROCKTON, ILLINOIS



VICINITY MAP
NOT TO SCALE



MONTGOMERY WATSON 1985

SITE LOCATION MAP
NOT TO SCALE

LIST OF DRAWINGS

DWG. NO.	TITLE
1	COVER SHEET, VICINITY MAP, SITE LOCATION MAP AND LIST OF DRAWINGS
2	EXISTING SITE CONDITIONS
3	NEW EXTRACTION WELL PLACEMENT AND TRENCH LOCATIONS
4	EXTRACTION AND MONITORING WELL CONSTRUCTION DETAILS
5	EQUIPMENT LAYOUT
6	PIPING LOCATION
7	BUILDING FOUNDATION
8	BUILDING ELEVATIONS
9	PROCESS AND INSTRUMENTATION DIAGRAM

DWG NO.	DATE	DESCRIPTION	NO.	DATE	DWN	APP'D	DESCRIPTION
38560090-D1	9/95	RA PLAN COVER SHEET-MONTGOMERY WATSON INC.	A	-	KMK	TC	-
REFERENCE DRAWINGS			REVISIONS				

ecology and environment engineering inc.

DESIGNED BY	CHECKED BY
T CAMPBELL P.E.	
DRAWN BY	APPROVED BY
KM KRAJEWSKI	N BROWN P.E.

BELOIT CORPORATION
BLACKHAWK FACILITY
ROCKTON ILLINOIS

REMEDIAL ACTION 95% DESIGN
COVER SHEET, VICINITY MAP, SITE LOCATION MAP AND LIST OF DRAWINGS

SCALE	FIRST ISSUED	C.A.D. FILE NO.	DRAWING NO.	REV.
NOTED	06-01-07	Beloit 95%_1-9.dwg	Sheet - 1 of 9	A

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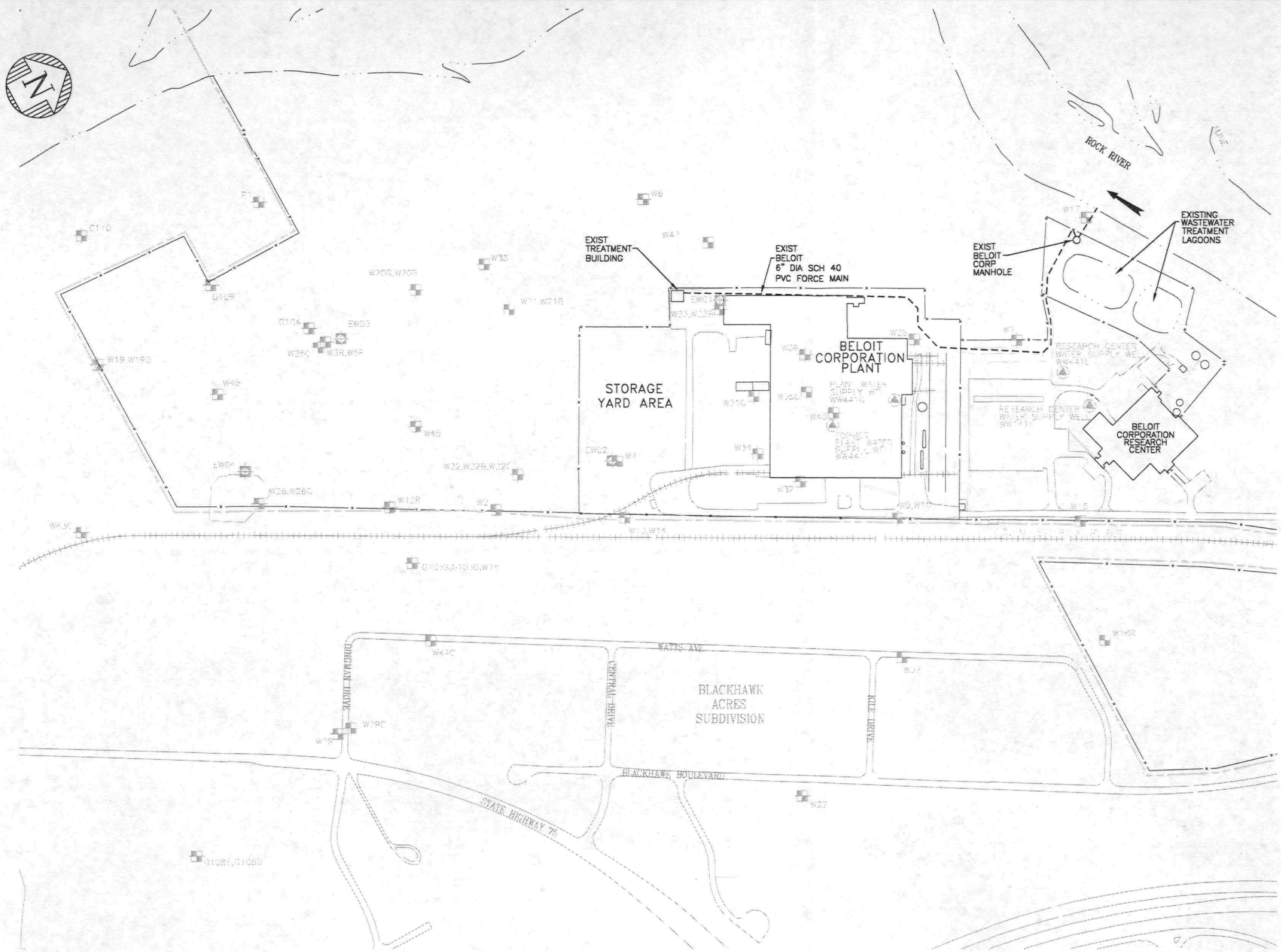
BUFFplot: 5/14/07 KMK



EXISTING SITE CONDITIONS

SCALE: 1" = 200'-0"

NOTES:

1. NO RECORD DRAWINGS OF EXISTING PIPELINE WERE AVAILABLE.

LEGEND

- EXISTING EFFLUENT UNDERGROUND PIPELINE ROUTE (APPROXIMATE)
- PROPERTY LINE (APPROXIMATE)
- FENCE LINE
- RAILROAD TRACKS
- W19,W19B (771.88') MONITORING WELL NUMBER AND LOCATION (STATIC WATER ELEVATION)
  - W_# # = SHALLOW WELL
  - W_#B# = INTERMEDIATE WELL
  - W_#C# = DEEP WELL
  - R = REPLACED WELL
  - G_# # = GOVERNMENT WELL
  - D = DEEP
  - S = SHALLOW
- EW01 EXTRACTION WELL NUMBER AND LOCATION
- PLANT WATER SUPPLY WELL WW441L MUNICIPAL OR INDUSTRIAL WATER SUPPLY WELL LOCATION

DWG NO.	DATE	DESCRIPTION	NO.	DATE	DWN	APP'D	DESCRIPTION
118337-1	8/7/06	SITE PLAN/WELL LOCS FROM BODINE ENVIRONMENTAL SERVICES INC.	A	-	KMK	TC	-

REFERENCE DRAWINGS — REVISIONS

ecology and environment engineering inc.

DESIGNED BY: T CAMPBELL P.E. — CHECKED BY:
DRAWN BY: KM KRAJEWSKI — APPROVED BY: N BROWN P.E.

BELOIT CORPORATION
BLACKHAWK FACILITY
ROCKTON — ILLINOIS

REMEDIAL ACTION 95% DESIGN
EXISTING SITE CONDITIONS

SCALE	FIRST ISSUED	C.A.D. FILE NO.	DRAWING NO.	REV.
AS NOTED	06-01-07	Beloit 95%_1-9.dwg	Sheet 2 of 9	A

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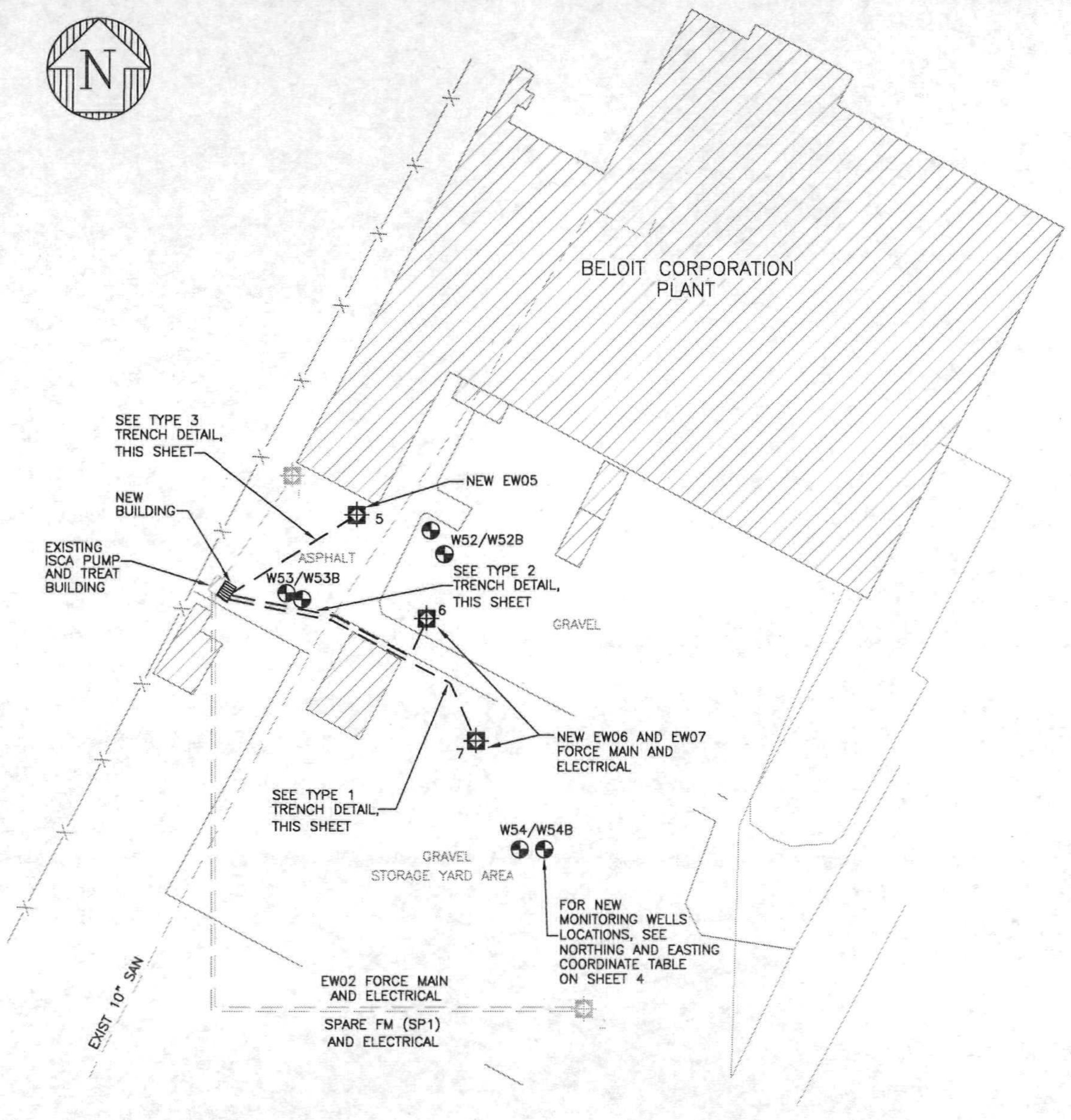
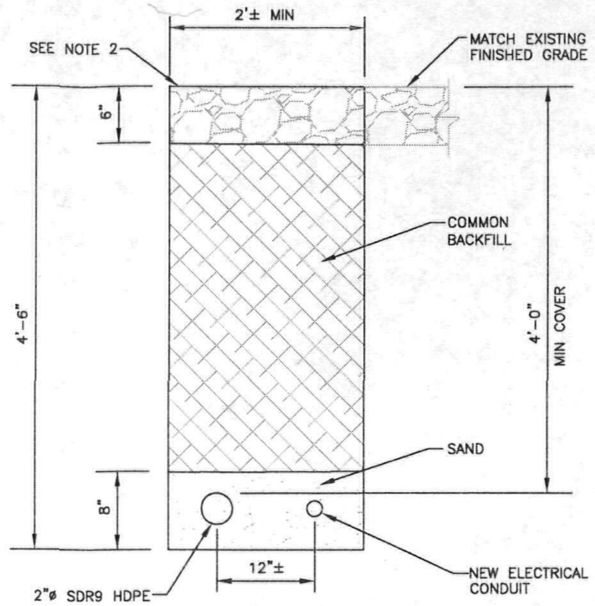
BUFFplot 5/14/07 KMK



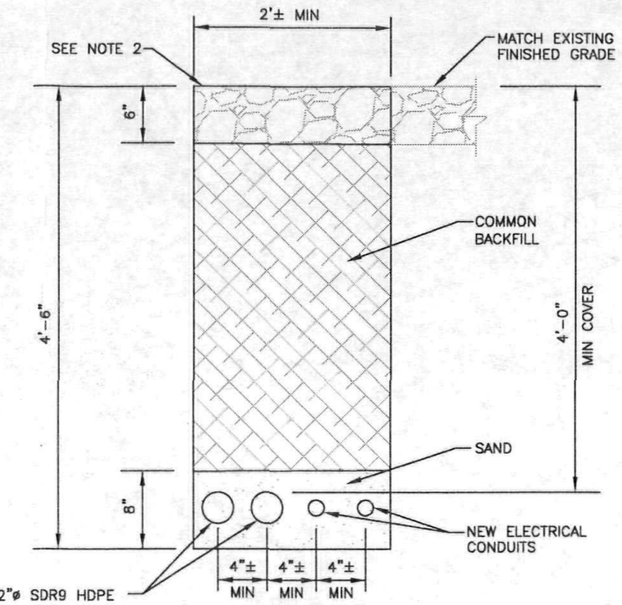
WELL AND TRENCH LOCATIONS

SCALE: 1" = 100'-0"



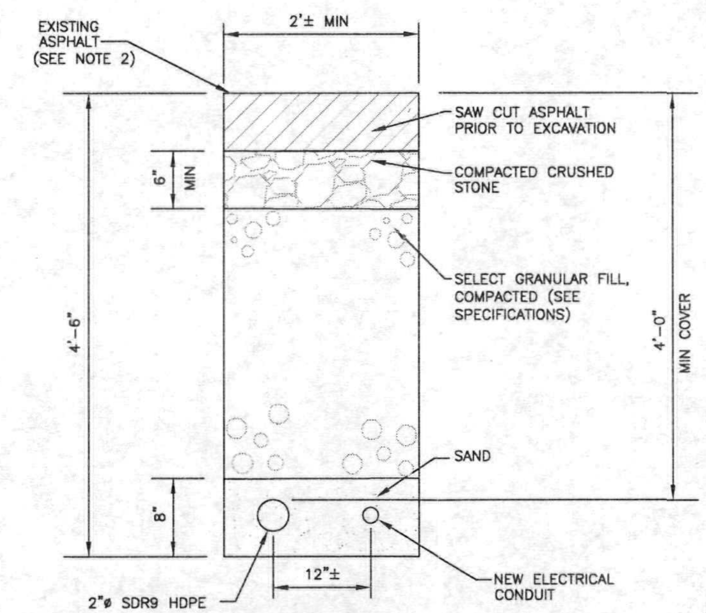
TYPE 1 TRENCH DETAIL

NOT TO SCALE



TYPE 2 TRENCH DETAIL

NOT TO SCALE



TYPE 3 TRENCH DETAIL IN PAVEMENT

NOT TO SCALE

LEGEND

1	EXISTING EXTRACTION WELL NUMBER AND LOCATION	— — —	PROPOSED UNDERGROUND PIPE TRENCH LOCATION
5	NEW EXTRACTION WELL NUMBER AND LOCATION	- - - -	EXISTING UNDERGROUND PIPE LOCATION
	NEW MONITORING WELL NUMBER AND LOCATION	—x—	EXISTING FENCE LOCATION
	NEW BUILDING		EXISTING BUILDING

GENERAL NOTES:

1. MAINTAIN 4' MIN COVER OVER ALL PUMP DISCHARGE PIPES.
2. RESTORE SURFACE TO MATCH EXISTING MATERIAL AND THICKNESS.
3. VERIFY LOCATION OF ALL UNDERGROUND UTILITIES PRIOR TO START OF CONSTRUCTION.
4. DETERMINE LOCATION AND DEPTH OF EXISTING SANITARY SEWER BY SURVEY AT AT MANHOLES OR BY TEST PITS.

NO.	DATE	DWN	APP'D	DESCRIPTION
A	-	KMK	TC	-

DWG NO.	DATE	DESCRIPTION
		REFERENCE DRAWINGS

ecology and environment engineering inc.

DESIGNED BY	CHECKED BY
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BELOIT CORPORATION
BLACKHAWK FACILITY

ROCKTON ILLINOIS

REMEDIAL ACTION 95% DESIGN
NEW EXTRACTION WELL PLACEMENT AND TRENCH LOCATIONS

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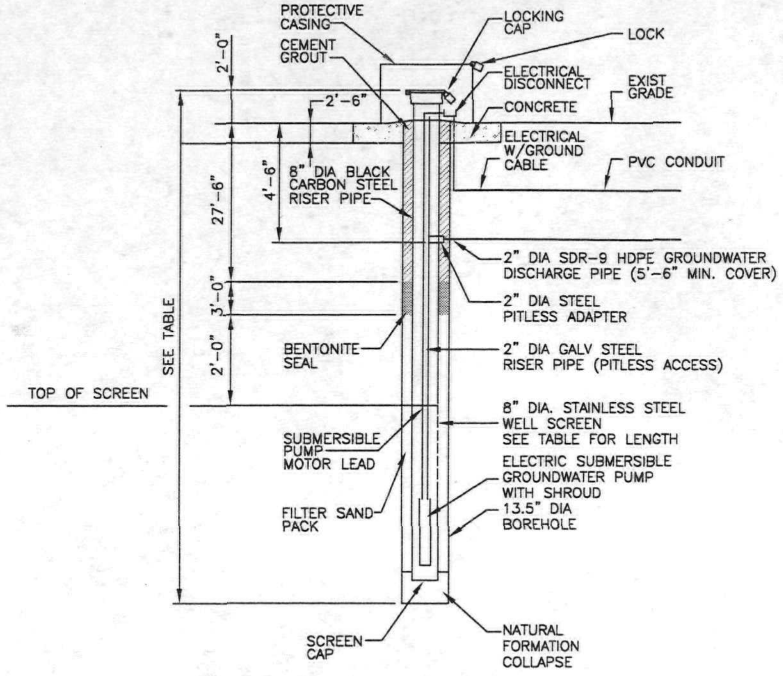
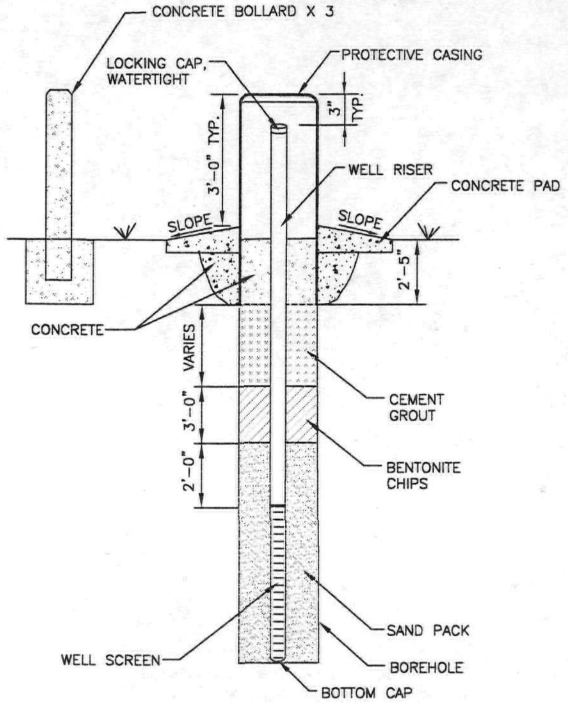
BUFFplot: 5/14/07 KMK



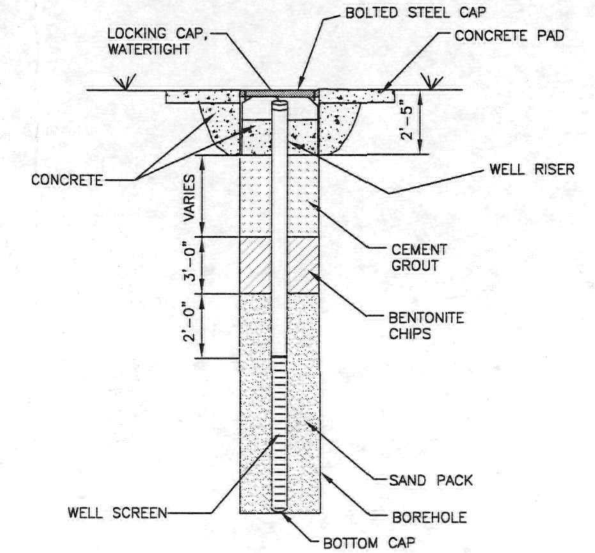
TYP. EXTRACTION WELL DETAIL

NOT TO SCALE



DETAIL STICKUP MONITORING WELL CONSTRUCTION

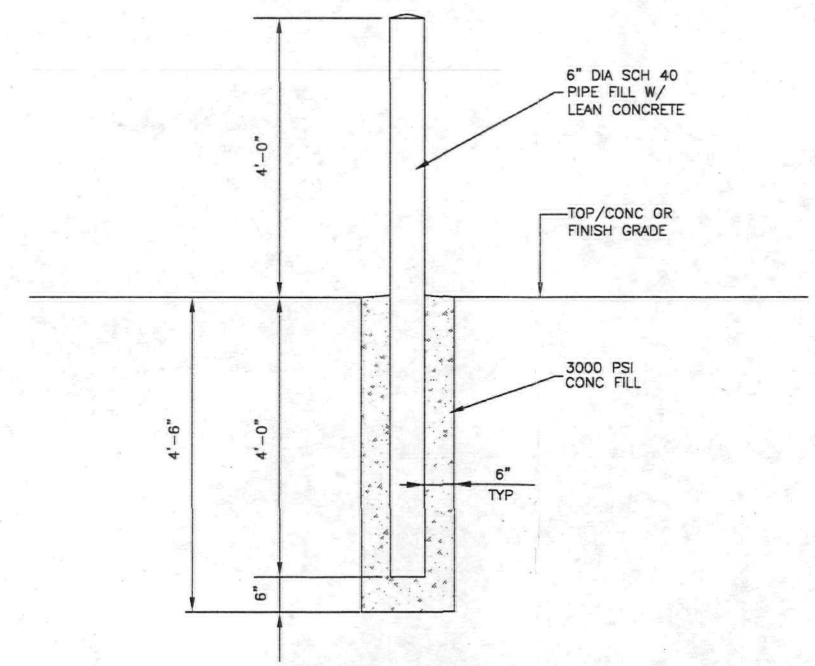
NOT TO SCALE



DETAIL FLUSH MOUNT MONITORING WELL CONSTRUCTION

NOT TO SCALE

EXTRACTION WELL TABLE						
PROPOSED WELL NO.	SCREEN LENGTH	DEPTH TO PUMP	TOTAL DEPTH	PNEUMATIC FRACTURING INTERVAL	NORTHING	EASTING
EW05	35'	55'	60'	24' TO 60'	2115125	796370
EW06	35'	55'	60'	24' TO 60'	2115000	796440
EW07	35'	55'	60'	24' TO 60'	2114865	796525



TYP BOLLARD DETAIL

SCALE: 3/4" = 1'-0"

MONITORING WELL TABLE					
PROPOSED WELL NO.	SCREEN LENGTH	TOTAL DEPTH	NORTHING	EASTING	COMPLETION
W52	10'	35'	2115075	796470	STICKUP
W52B	5'	55'	2115075	796470	STICKUP
W53	10'	35'	211500	796290	FLUSH
W53B	5'	55'	211500	796290	FLUSH
W54	10'	35'	2114790	796525	STICKUP
W54B	5'	55'	2114790	796525	STICKUP

DWG NO.	DATE	DESCRIPTION	NO.	DATE	DWN	APP'D	DESCRIPTION
			A	-	KMK	TC	-
REFERENCE DRAWINGS			REVISIONS				

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BELOIT CORPORATION
BLACKHAWK FACILITY
ROCKTON ILLINOIS

REMEDIAL ACTION 95% DESIGN
EXTRACTION AND MONITORING
WELL CONSTRUCTION DETAILS

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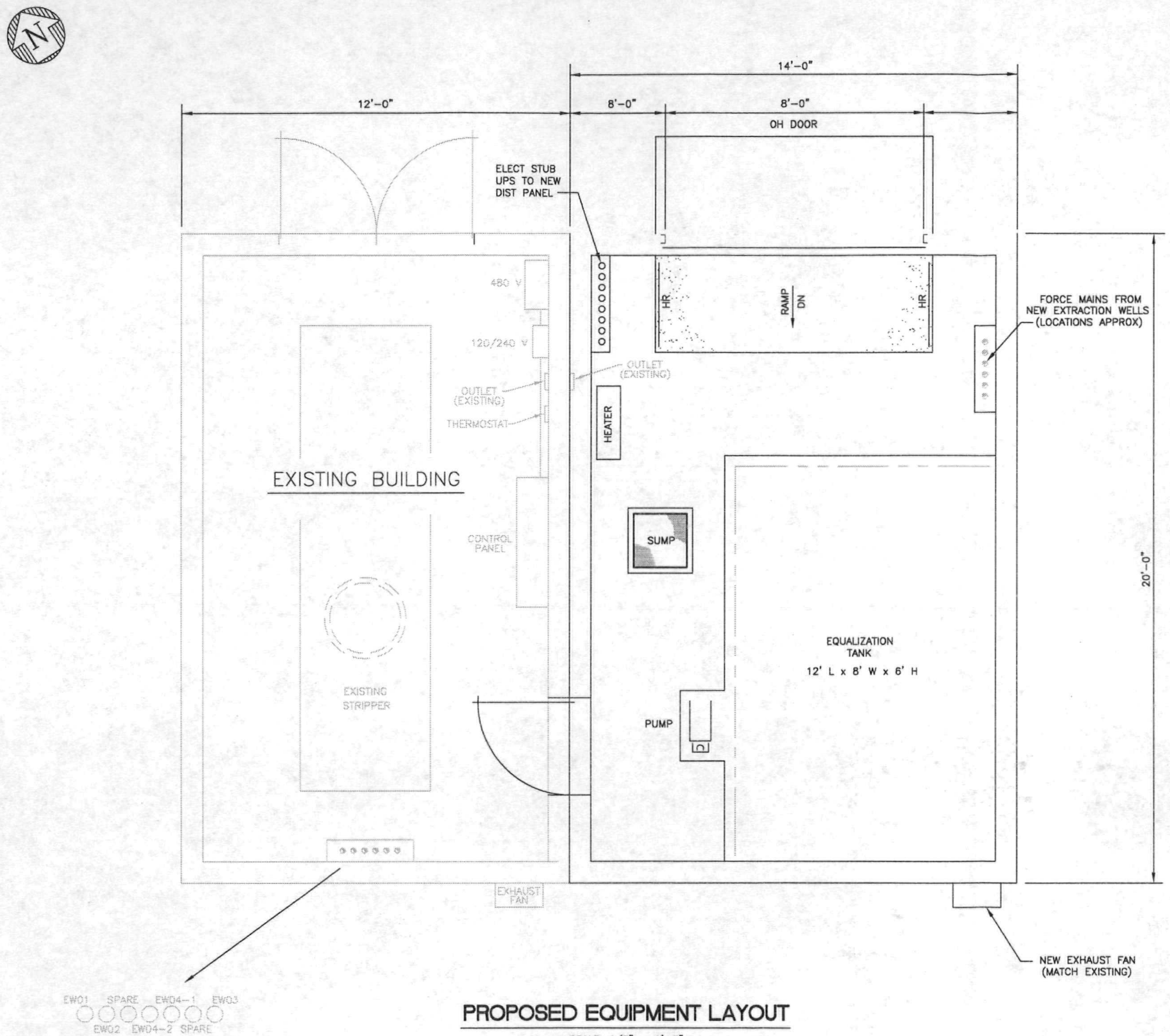
BUFFplot: 5/14/07 KMK



PROPOSED EQUIPMENT LAYOUT

SCALE: 1/2" = 1'-0"

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			A	-	KMK	TC	-
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BLACKHAWK FACILITY
ROCKTON ILLINOIS

REMEDIAL ACTION 95% DESIGN
EQUIPMENT LAYOUT

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AS NOTED	06-01-07	Beloit 95%_1-9.dwg	Sheet 5 of 9	A

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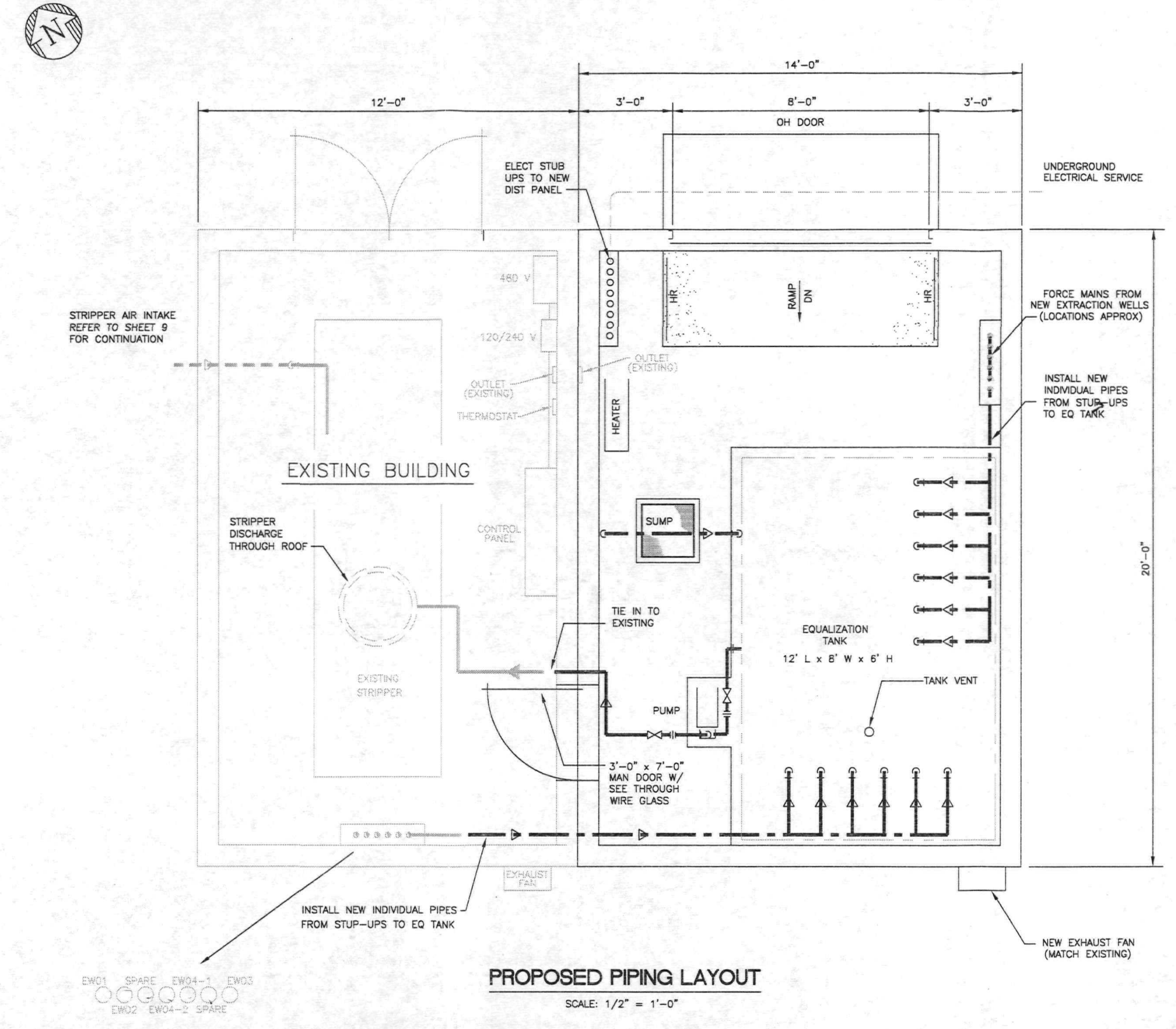
BUFFplot: 5/14/07 KMK



PROPOSED PIPING LAYOUT

SCALE: 1/2" = 1'-0"

LEGEND

- INFLUENT PIPING FROM EXTRACTION WELLS
- INFLUENT PIPING FROM EQ TANK
- EFFLUENT PIPING FROM STRIPPER TO DISCHARGE

GENERAL NOTES

1. LOCATIONS OF EXISTING PROCESS EQUIPMENT, ELECTRICAL CONNECTIONS, PANELS, STUB UPS AND INTERCONNECTION POINTS SHOWN ON THIS DRAWING ARE APPROXIMATE. CONTRACTOR SHALL VERIFY LOCATIONS OF ALL UTILITIES AND STRUCTURAL COMPONENTS PRIOR TO FABRICATION.
2. PROPOSED PROCESS PIPING SHALL BE SUPPORTED BY BUILDING STRUCTURE. NUMBER AND LOCATION OF PIPES SHOWN ON PLAN THIS SHEET. ASSUME 3 LB PER LINEAL FOOT FOR EACH 2" PIPE AND 15 LB PER LIN FT FOR EACH 6" PIPE. ACCOUNT FOR WEIGHT OF ALL VALVES AND OTHER PIPE ACCESSORIES.
3. CONTRACTOR SHALL DETERMINE METHOD OF PIPE SUPPORT FROM BLDG STRUCTURE AND OBTAIN APPROVAL FROM BLDG FABRICATOR. SPACE PIPE SUPPORTS TO CONFORM WITH PIPE MANUFACTURERS NORMAL SUPPORT SPACING.

DWG NO.	DATE	DESCRIPTION	NO.	DATE	DWN	APP'D	DESCRIPTION
			A	-	KMK	TC	-
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BLACKHAWK FACILITY
ROCKTON ILLINOIS

REMEDIAL ACTION 95% DESIGN
PIPING LOCATION

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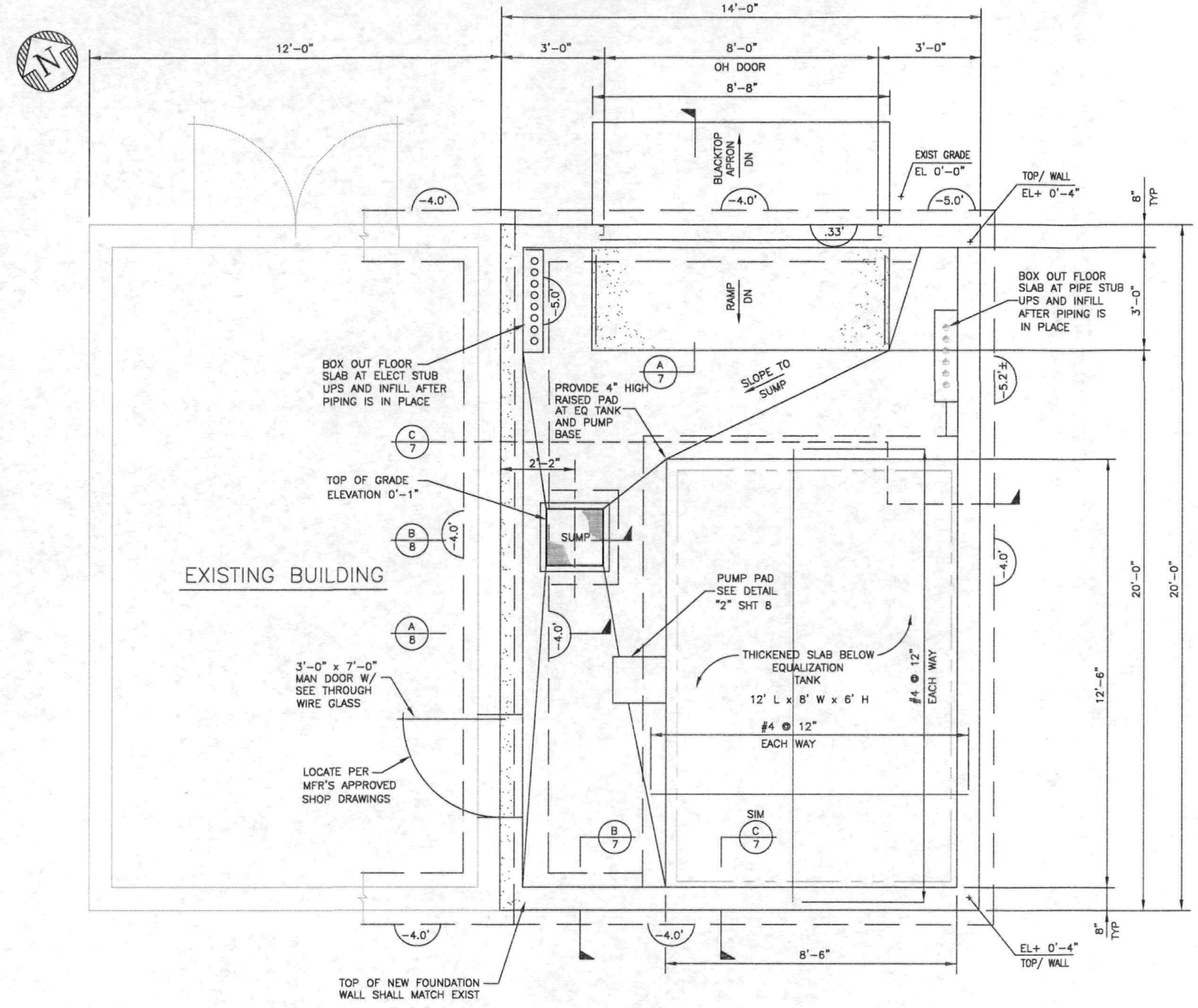
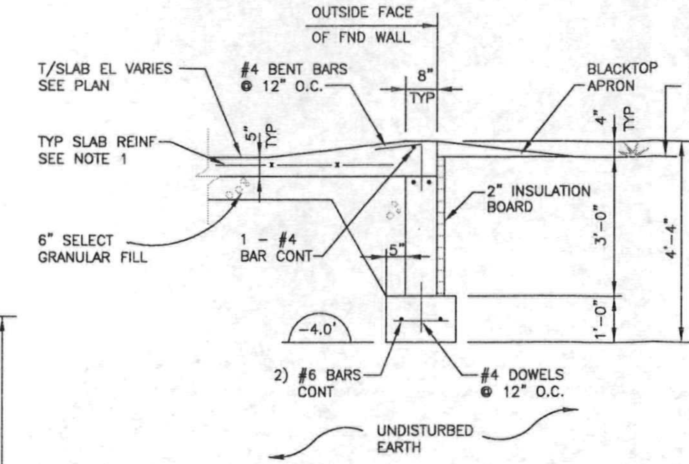


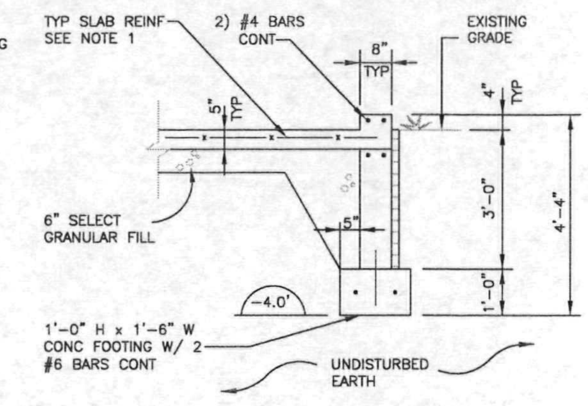
PROPOSED BUILDING FOUNDATION - PLAN

SCALE: 1/2" = 1'-0"



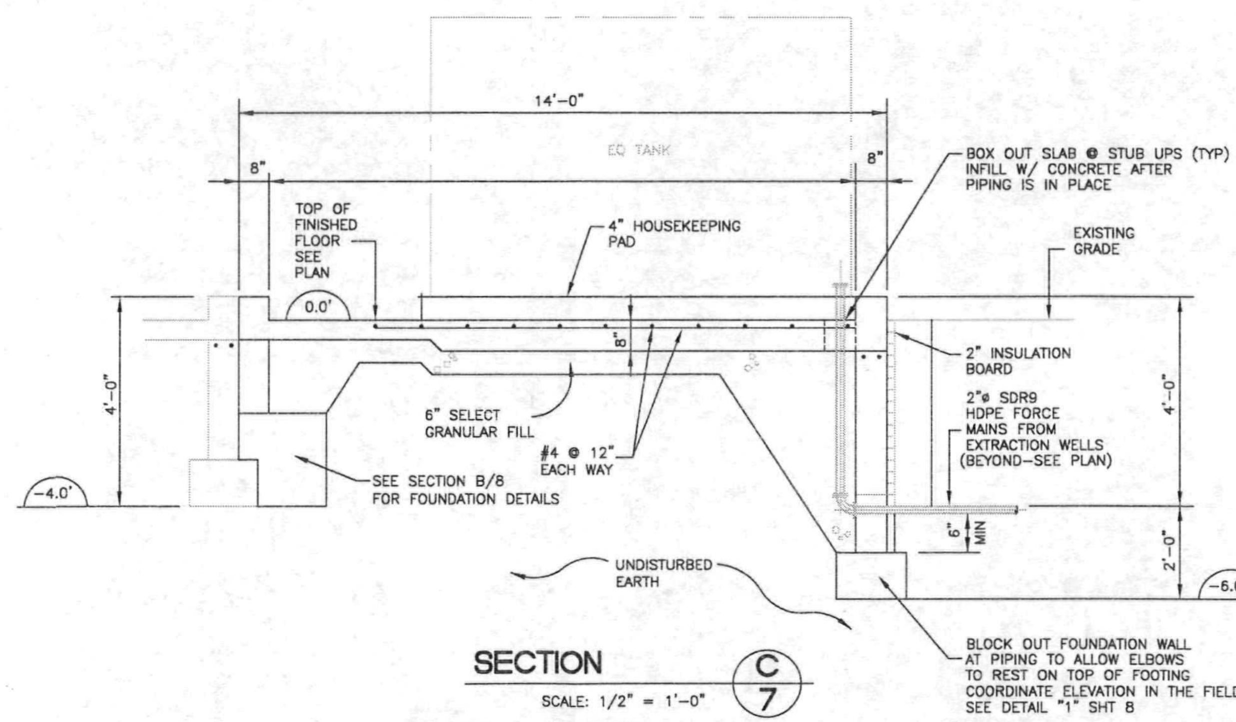
SECTION A/7

SCALE: 1/2" = 1'-0"



SECTION B/7

SCALE: 1/2" = 1'-0"



SECTION C/7

SCALE: 1/2" = 1'-0"

GENERAL NOTES

1. FLOOR CONSTRUCTION SHALL BE 5" CONCRETE SLAB ON COMPACTED FILL WITH 6 x 6 x W 4.0 x W 4.0 WELDED WIRE FABRIC EXCEPT AS NOTED ON PLAN.
2. FINISH FLOOR ELEVATION IS 0'-0".
3. CONSTRUCTION AND CONTROL JOINTS ARE NOTED ON PLAN. SEE TYPICAL DETAILS THIS DWG.
4. BOTTOM OF FOOTING INDICATOR SHOWN THUS (-X.X') ON PLAN DENOTES DISTANCE FROM FINISH FLOOR TO BOTTOM OF FOOTING.

DWG NO.	DATE	DESCRIPTION	NO.	DATE	DWN	APP'D	DESCRIPTION
			A	-	KMK	TC	-
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BLACKHAWK FACILITY
ROCKTON ILLINOIS

REMEDIAL ACTION 95% DESIGN
BUILDING FOUNDATION

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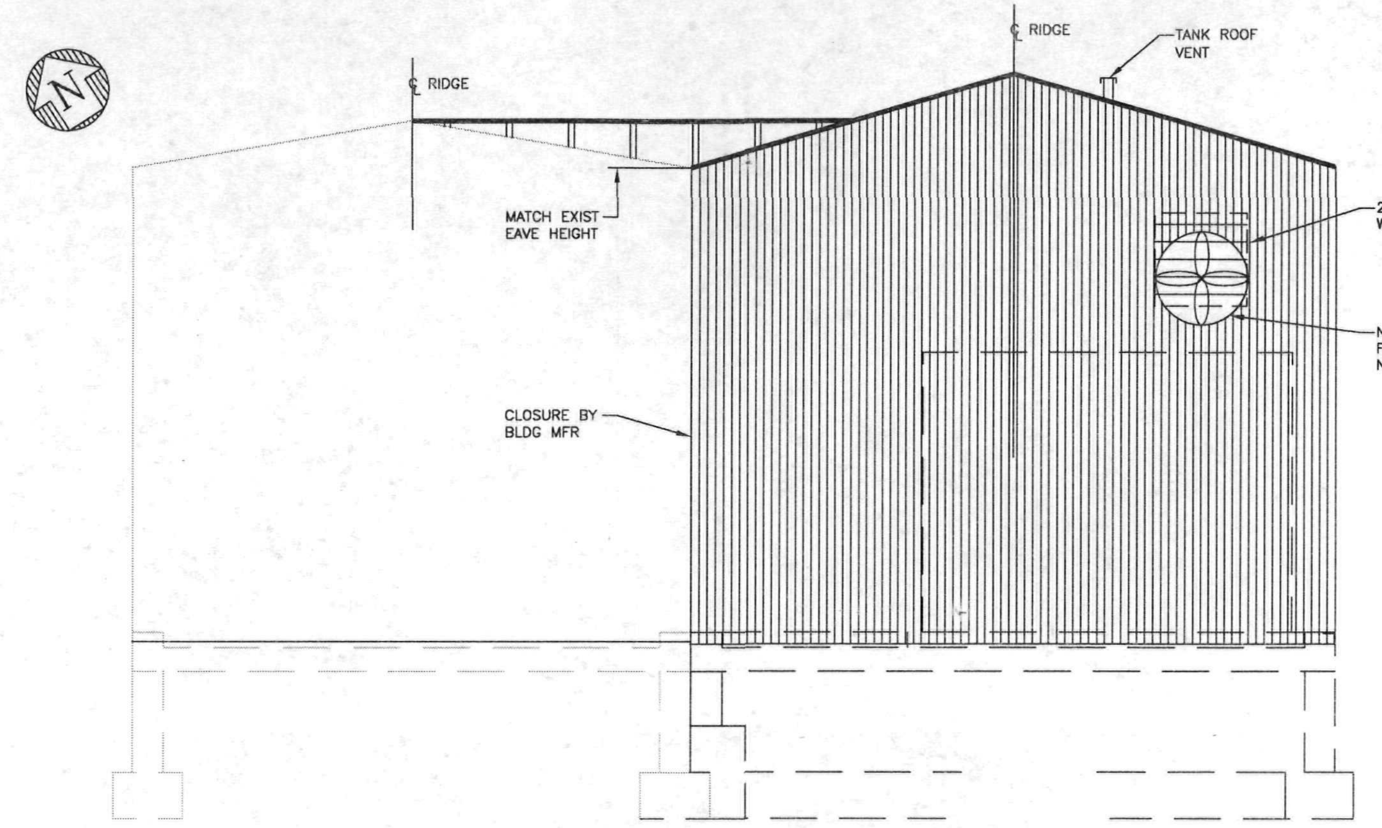
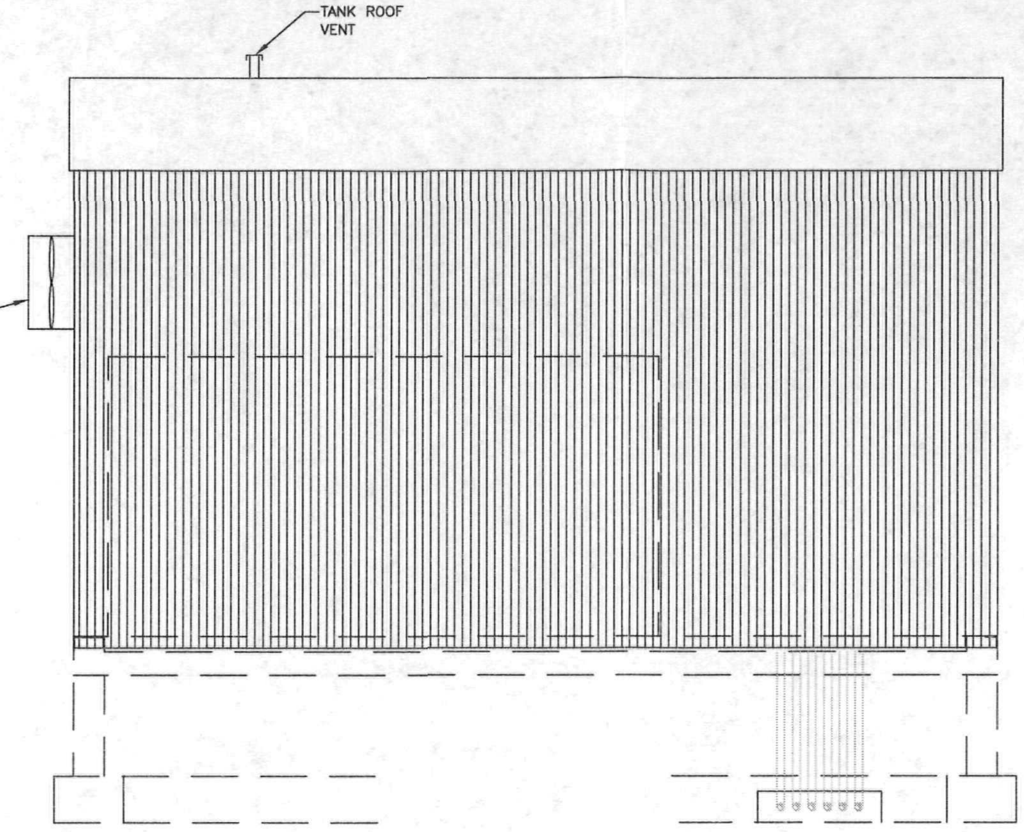
BUFFplot: 5/16/07 JJK



SOUTH ELEVATION

SCALE: 1/2" = 1'-0" (LOOKING NORTH)

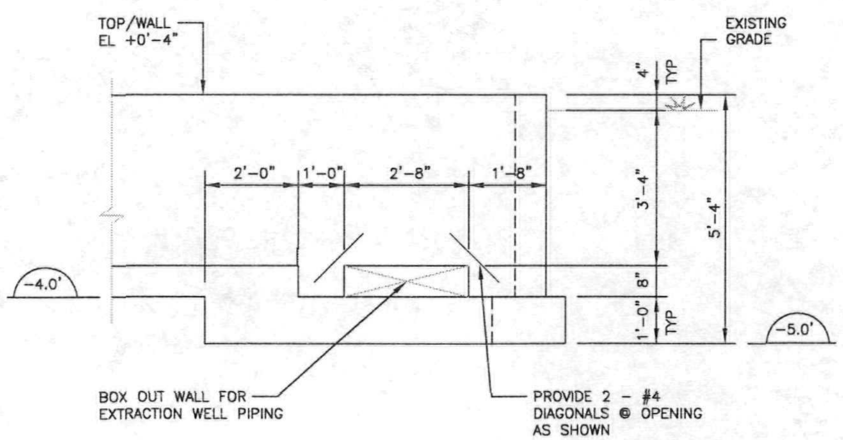


EAST ELEVATION

SCALE: 1/2" = 1'-0" (LOOKING WEST)

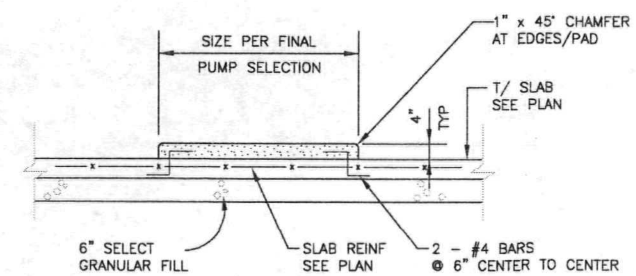
NOTE

1. EXHAUST FAN SIZE AND HEIGHT TO MATCH EXISTING.



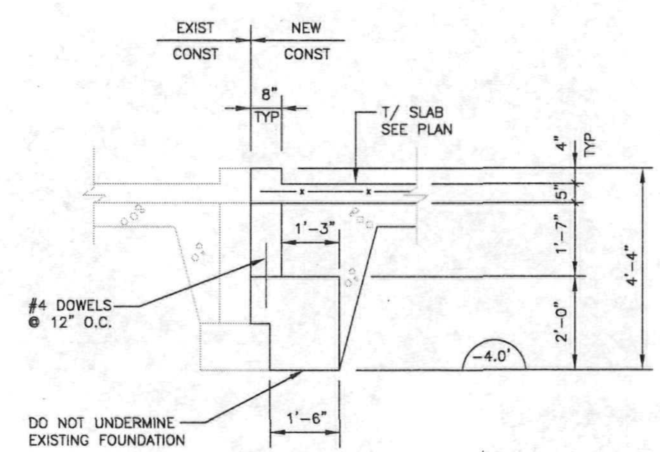
DETAIL "1"

SCALE: 1/2" = 1'-0"



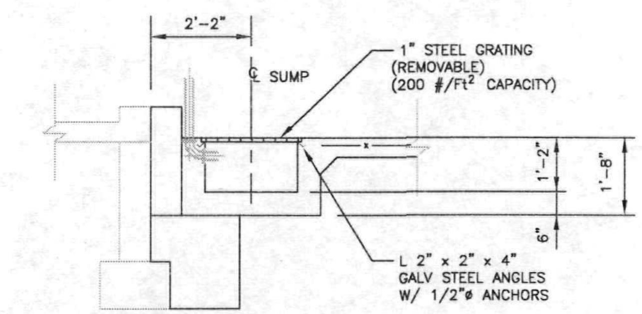
DETAIL "2"

SCALE: 1/2" = 1'-0"



SECTION (A/8)

SCALE: 1/2" = 1'-0"



SECTION (B/8)

SCALE: 1/2" = 1'-0"

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			A	-	KMK	TC	-
REFERENCE DRAWINGS			REVISIONS				

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BELOIT CORPORATION
BLACKHAWK FACILITY
ROCKTON ILLINOIS

REMEDIAL ACTION 95% DESIGN
BUILDING ELEVATIONS

SCALE	FIRST ISSUED	C.A.D. FILE NO.	DRAWING NO.	REV.
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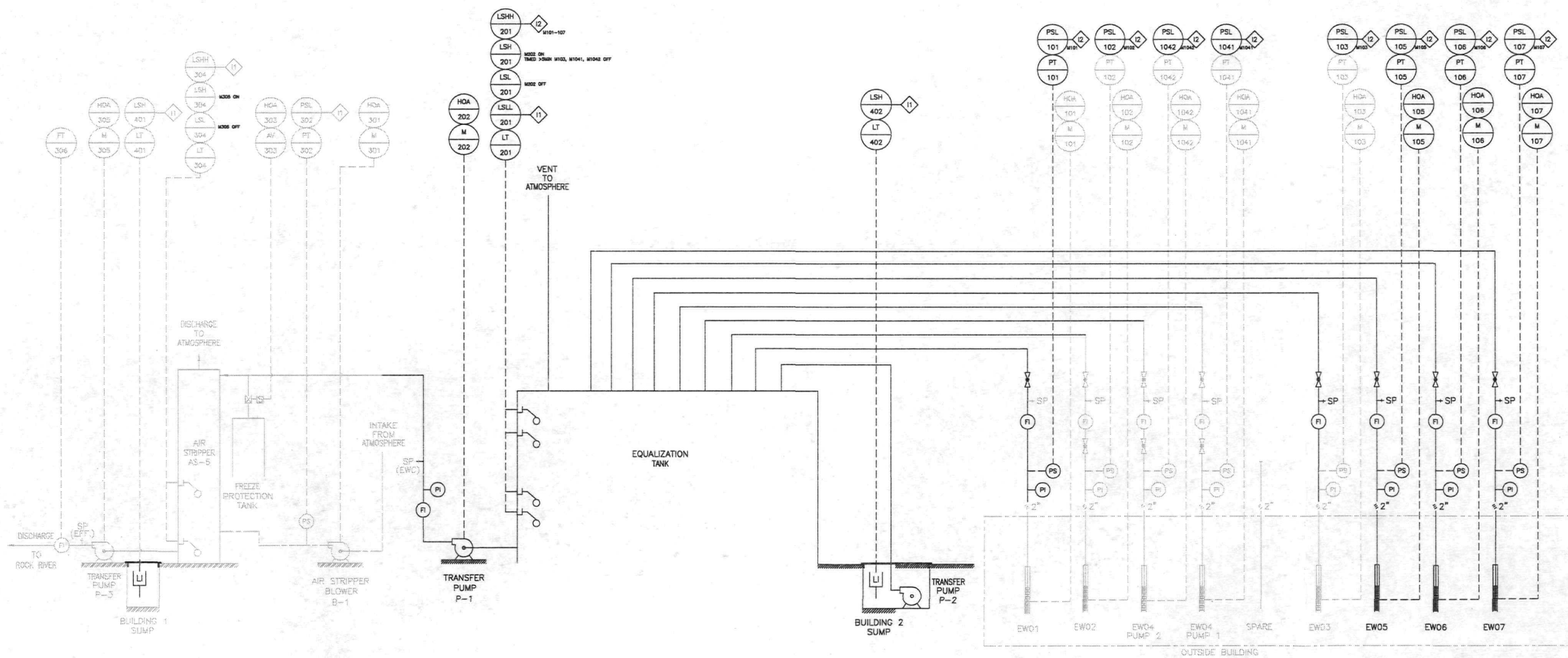
BLIFFplot: 5/16/07 JJK

LEGEND

HOA XXX	HAND-OFF-AUTOMATIC SWITCH
XXX XXX	CONTROL PANEL UNIT OR FUNCTION
I1	INTERLOCK SHUTS DOWN ENTIRE SYSTEM
I2	INTERLOCK SHUTS DOWN INDICATED SYSTEM COMPONENTS
LT	LEVEL TRANSMITTER
FT	FLOW TRANSMITTER
PT	PRESSURE TRANSMITTER
AV	ACTUATED VALVE
H/HH	SWITCH HIGH OR HIGH-HIGH
L/LL	SWITCH LOW OR LOW-LOW
PI	PRESSURE INDICATOR
LI	LEVEL INDICATOR
PS	PRESSURE SWITCH
FI	FLOW INDICATOR
-SP	SAMPLE PORT (NAME)
	SOLENOID VALVE
	LEVEL SWITCH
	SYMBOL INDICATES CHANGE IN PIPING MATERIAL
LI	LEVEL INDICATOR
	BALL VALVE
M	MOTOR

DARKER/BOLDER LINES INDICATE SYSTEM UPGRADES



			A	-	KMK	TC	-
DWG NO.	DATE	DESCRIPTION	NO.	DATE	DWN	APP'D	DESCRIPTION
REFERENCE DRAWINGS			REVISIONS				

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BELOIT CORPORATION
BLACKHAWK FACILITY

ROCKTON ILLINOIS

REMEDIAL ACTION 95% DESIGN
PROCESS AND INSTRUMENTATION DIAGRAM

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BUFFplot: 5/14/07 KMK